1954

Plankton studies of the Tomales Bay, California : a thesis ...

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PLANKTON STUDIES OF
THE TOMALES BAY, CALIFORNIA

A Thesis

Presented to

the Faculty of the Department of Zoology

College of the Pacific

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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by

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TABLE OF CONTENTS

PAGE

PAGE

INTRODUCTION

These studies on the plankton of Tomales Bay were designed to determine the effects of such physical factors as tides, temperatures, salinities and sunshine on the quantities of various types of organisms, and to obtain a more comprehensive picture of estuarine life at the Pacific Marine Station. The studies were begun in the summer of 1948 and continued through the summer of 1953.

Although various studies have been conducted on different aspects of marine plankton, the only general treatments of the subject of which the writer is aware are those of Johnstone (1924), Ricketts and Calvin (1951), Sproston (1949) and Sverdrup (1946). It is hoped that these additional studies will be of general interest to biologists and that they may form the basis for the solution of some of the many intriguing problems which have been encountered and are here presented in graphic form.

The writer wishes to express his sincere appreciation to Dr. Alden E. Noble, Director of the Pacific Marine Station, under whose able direction this investigation was undertaken, for his many valuable suggestions and criticisms throughout the progress of this research.

COLLECTING AREA

Plankton collections used in this investigation were taken from the eighteen mile long Tomales Bay (Plate 7) which is located 38°14'2" latitude and 122°59'58" longitude. The bay is located in Marin County, California, on the San Andreas fault line which also transverses Bolinas Bay, San Francisco City and County. This fault line separates the Point Reyes Block from the mainland. The Block, according to Dickerson (1922), is supposed to have been an island during much of the tertiary times, perhaps connected with the Farallons on the southwest. Its mesozoic granites are exposed along the western shore of the point at the entrance of the present Tomales Bay.

The eastern shore of Tomales Bay was once part of the bed of the ancient Pleiocene Merced Sea. Along most of this shore, Merced deposits have been eroded exposing the much older Jurassic Franciscan deposits. On the northern shore, and partly closing the entrance, is a large sand dune area which is of a much younger Pleistocene and Recent alluvial deposit. The width of Tomales Bay is variable but mostly about one mile. The channel ranges between thirty-eight and fifty-four feet in depth. The bay's middle averages twenty feet.

The tides at the mouth of the bay, according to the Coast and Geodetic Survey (1952), are five minutes earlier than are those at the Golden Gate. The tidal difference between the mouth of the bay and Nick's Cove (Plate 8), where the samples of this investigation were taken, is sixty minutes. The interval between the high tides is eleven hours and twenty-two minutes. The lowest maximum tide which has been recorded is minus 2.10, and the highest maximum is a plus 6.5 feet.

The collections were made at the end of the pier at Nick's Cove (Plate 8). This pier extends about 640 feet from the shore to an area over the water which is about eight feet deep at lowest tide level. The substrate of this area is of muddy-silt type, but nearby there is a large area with a considerable stand of eel grass, Zostera spp., and towards the shore a large area of sea lettuce, Entermorphia spp., covers the rocky bottom. About five hundred yards south of the pier are large rock outcroppings, and about one thousand yards to the north are the extensive oyster beds which at one time provided a major industry for the area. Although occasional plankton tows were made from the station's boat, Bios Pacifica, and many samples were taken off Tom's Point, these have not been included in this investigation.

PROCEDURES

A total of 120 plankton samples were obtained during a period of eighty-five days. Each sample was procured by drawing an open twelve inch, twenty-four guage mesh, standard plankton net (Plate 10) through the water at a depth of approximately one foot.

At each sampling, the surface and subsurface temperatures were recorded; notations as to the general weather conditions were noted on the check sheet (Plate 11). Collected at this time was a pint sample of sea water to be taken to the laboratory for determination of salinity.

After the sample was brought into the laboratory, it was placed in a large culture bowl so that the macroplankton could be removed and counted. Fifteen ml were taken immediately after agitation of the sample, this being taken by the use of a various sized pipette. The sample was placed in a Syracuse watch glass under the Stereoscopic microscope for a more detailed examination. A smaller pipette was used, and the material was transferred to a depression slide for examination under a compound microscope. The sample was analyzed by listing on the check sheet (Plate 11) the first 200 to 300 organisms of all types encountered.

From the figures thus obtained, the relative abundance of the various plankton types could be calculated. The entire remainder of each sample was then placed in a quart sized museum jar and preserved with ten per cent neutralized formalin in sea water. The jars were labeled and placed in the museum of the Pacific Marine Station, Dillon Beach, Marin County, California, for identification and evaluation at a later time or for the use of other workers. The salinity of the pint water sample was done by the use of a hydrometer, calibrated for salt water, and the reading corrected to Knudsen's (1946) Hydrographic Tables.

In a tidal flow experiment, a standard U. S. Navy flow register was attached to a half-filled five gallon water bottle. The exact time of the tidal change was observed by the change of the direction of the current and checked with the U. S. Coast and Geodetic Tide Table (1952). The apparatus was then released into the water and was followed in a boat. The path taken by the bottle was then marked or plotted on a standard navigation map, both the path and the time intervals being recorded (Plate 9). The bottle was removed when the tide changed five hours and eleven minutes later.

DISCUSSION

While the results of this investigation are completely tabulated in the form of charts and graphs comprising the bulk of this thesis, there are a few generalizations to which attention should be especially directed.

The range in salinity was slight during the time these studies were undertaken, ranging from a density (Department of Commerce, 1950) of 1.0330 to 1.0345. The average for the high tide period was 1.0330, and the average for the low tide period was 1.0310. During the winter rain and the spring flows, there is probability of a heavy dilution, lowering the salinity content of the water to as much as 1.0160 (Table 5). The higher salinities are due to the inflow of the open ocean water; lower ones are due to the flow of the bay's water back to the ocean, the influx of fresh water from the very small streams and natural seepage from springs. There are greater variations in salinity during low tides as contrasted with relative constancy at high tides. One should note the sharp decrease in the salinity during June 27-July 4 which is correlated with an unusual summer rain.

The temperature range was 11-17.8 degrees C. The average high tide temperature being 13.8 degrees C., and the average low tide temperature being 17.2 degrees C. These

variations are because the water has an opportunity to become warmer in the bay. During the high tide, the bay receives the maximum amount of open ocean water and thereby becomes lower in temperature; but, before the following low tide occurs, atmospheric temperatures are able to affect the relatively small body of water constituting the bay. It should be noted during the periods when the bay's low tide temperatures were high the corresponding temperatures during high tide were higher. The variance of the surface water temperature and that of the deeper layers (eight-nine feet) at either high or low tide was only 0.5 degrees C.

The increase in the quantity of phytoplankton precedes the increase in zooplankton on the average of two days. Every marked drop in the number of phytoplankton is followed by a comparable drop in zooplankton within two days. There was a decrease in the low tide total plankton from June 25 to July 18, in contrast with lesser drop in the high tide, which was evidentally due to a decrease in the number of bay fauna and flora (Charts 8, 9, 12 and 13). For example, such open-sea forms as Noctiluca were well represented, but there was a decrease in the number of trochophores which usually abound in the bay. The occasional drops in total numbers are without demonstrable reasons, but are probably merely indicative of

seasonal changes in reproductive cycles. There is no evidence of rythmical decreases and increases, at least in Tomales Bay during the summer months. Zooplankton was consistently more abundant after dark, indicating a rise from the deeper waters and probably some degree of negative phototropism of many forms. The phytoplankton decreases at night by sinking to lower levels. All the forms of phytoplankton and larval ascidians were found to be more or less predominant during the day. The following were more or less predominant during the night: medusae, trochophores, veligers, plutei, megalops, nauplei and miscellaneous crustaceae. Tintinnids, ctenophores and zoea were found in equal numbers during the day and night. The following selected types reached their peak in numbers during the following months: June: dinoflagellates, trochophores; late June and the first part of July: noctiluca, dinoflagellates, trochophores; July: noctiluca, dinoflagellates, medusae, trochophores, larval ascidians, plutei, veligers; September: trochophores, veligers, megalops, nauplei, zoea.

Low tide collections showed an increase of bay inhabiting forms, especially larvae of annelids, clams and phoronids. Conversely, high tide brought an influx of open sea forms. Reliance on these facts make possible some determinations of the sources of species showing increases.

For example, a heavy increase of plutei during high tide in August when none could be found at low tide suggests that open coast sea urchins or offshore sand dollars are reproducing at that time. Conversely a marked decrease in mysids from the low tide collections during June suggests that the species is a bay form or at least is more or less confined to the bay at this time. Bipinnaria abounding in low tide collections during July indicate estuarine reproduction, possibly that of Piaster brevispinus, since Pateria miniata is known to be as prolific in June as in July. Another increase of bipinnaria in high tide collections during August indicates a seasonal activity probably on the part of Piaster ochraceous. It would undoubtedly be possible to correlate this series of charts (eighteen-twenty-five) with the results of the experiment on the tidal currents in the bay (Plate 9), and in so doing select the time most likely to yield a particular species or type of organism.

SUMMARY

Studies on the plankton of Tomales Bay have been conducted during the summers and to a lesser degree throughout the years of 1948-1953. Tables, charts and plates are here presented to show the effects of selected physical agencies on the planktonic composition of sea water in the bay and to show some of the biological interrelationships of marine organisms, especially those involving life cycles.

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EXPLANATION OF CHARTS

CHART 1

Records of salinities and temperatures during high and low tides at Nick's Cove during the summer of 1952.

CHARTS 2 AND 3

Records of total quantities of Phytoplankton and Zooplankton, day and night combined, collected at Nick's Cove during high tide (Chart 1) and during low tide (Chart 2) indicates: (1) relatively few plankton organisms; (2) they were plentiful; and (3) they were very abundant.

CHARTS 4 AND 5

Records of total quantities of Phytoplankton and Zooplankton occuring at Nick's Cove at high tide during the day (Chart 4) and during high tide at night (Chart 5) indicates: (1) relatively few organisms; (2) they were plentiful; and (3) they were very abundant.

CHARTS 6 TO 17

Records of the increase and decrease in numbers of selected constituents as collected during the day (Charts 6, 8, 10, 12, 14, 18) and during the night (Charts 7, 9, 11, 13, 15, 17). Criteria of selection of animals were: (1) their

significance in terms of life cycles; and (2) their known occurence in open seas in some cases and their known estuarine proclivities in others. Charts are arranged so that the record of a species occuring during the day may be compared with its nocturnal records on the immediately following chart. Figure 1 indicates relatively few organisms, figure 2 indicates that they were plentiful, and figure 3 indicates that they were very abundant.

CHARTS 18 TO 25

Records of the increase and decrease in numbers of selected species collected during the day at high tide (Charts 18, 20, 22, 24) and at low tide (Charts 19, 21, 23, 25). Charts are arranged so that the record of a species occuring during the day may be compared with its nocturnal record on the immediately following chart. Criteria of selection of species were: (1) their probable significance in studies on life cycles; and (2) the fact that some are known to be primary inhabitants of the open sea while others are predominantly estuarine. Figure 1 indicates relatively few individuals present, figure 2 indicates that many were present, and figure 3 indicates that they were very abundant.

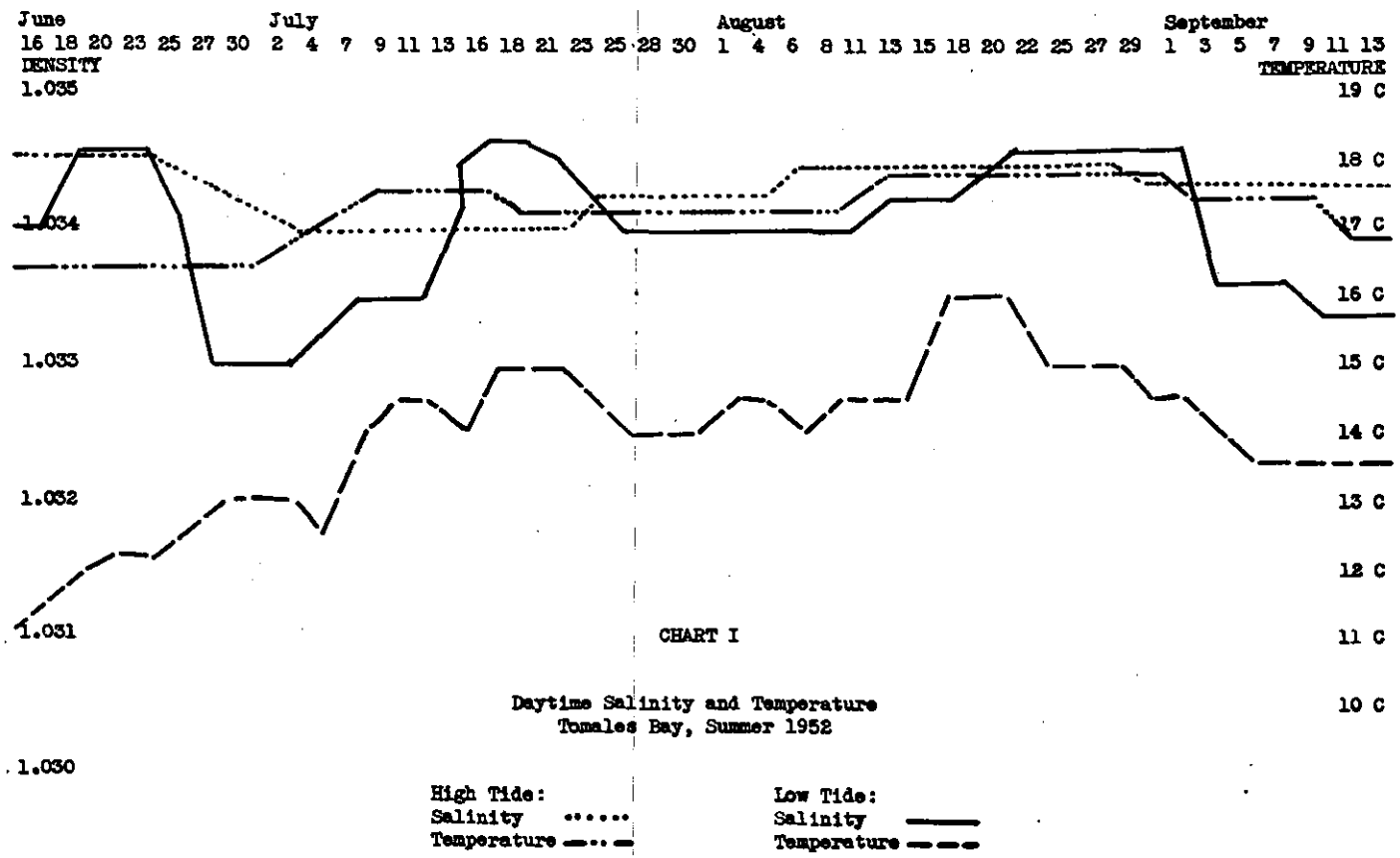


CHART I

Daytime Salinity and Temperature
Tomales Bay, Summer 1952

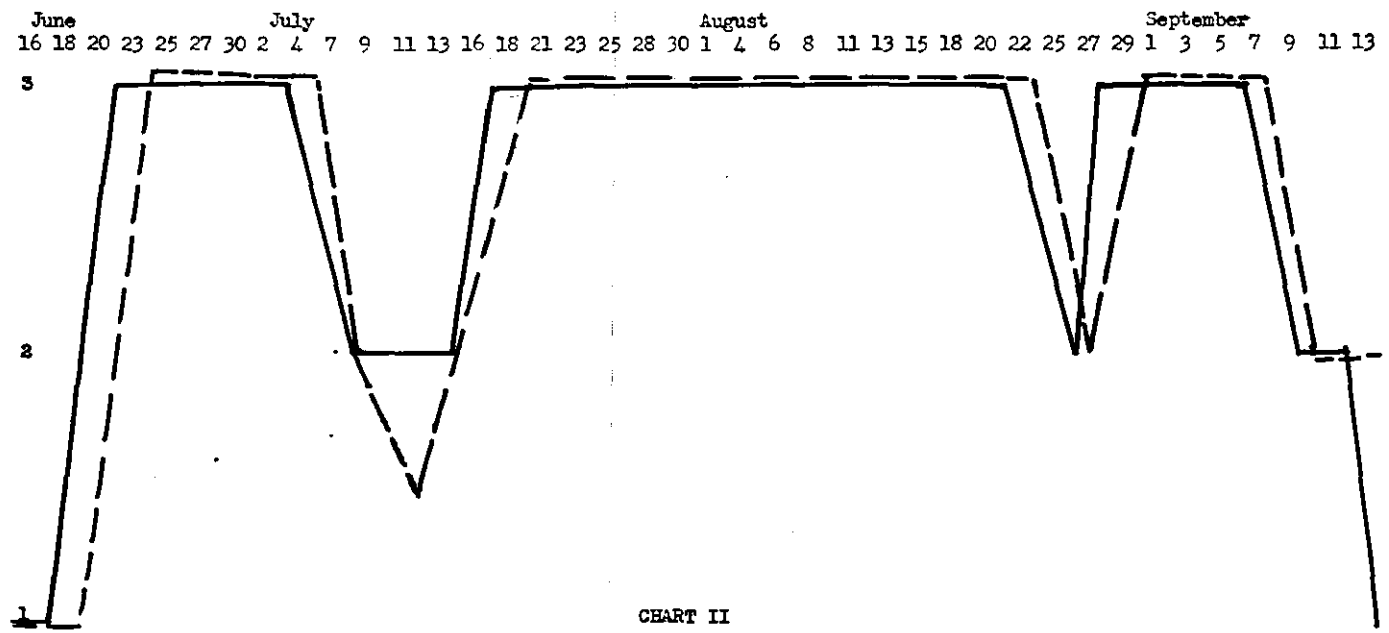


CHART II

High Tide, Day and Night Combined

Total Phytoplankton ——

Total Zooplankton — — —

Key:
1 - one or few
2 - common
3 - abundant or dominant

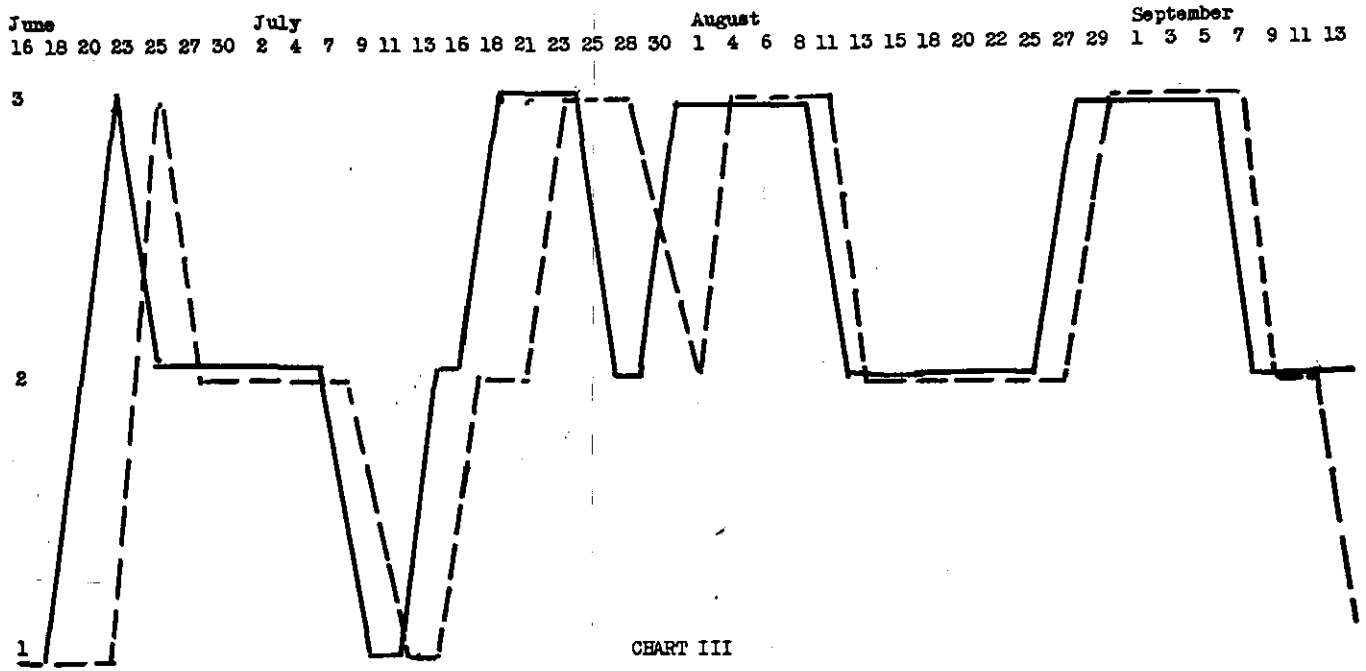


CHART III

Low Tide, Day and Night Combined

Total Phytoplankton ——

Total Zooplankton – – –

Key:
1 - one or few
2 - common
3 - abundant or dominant

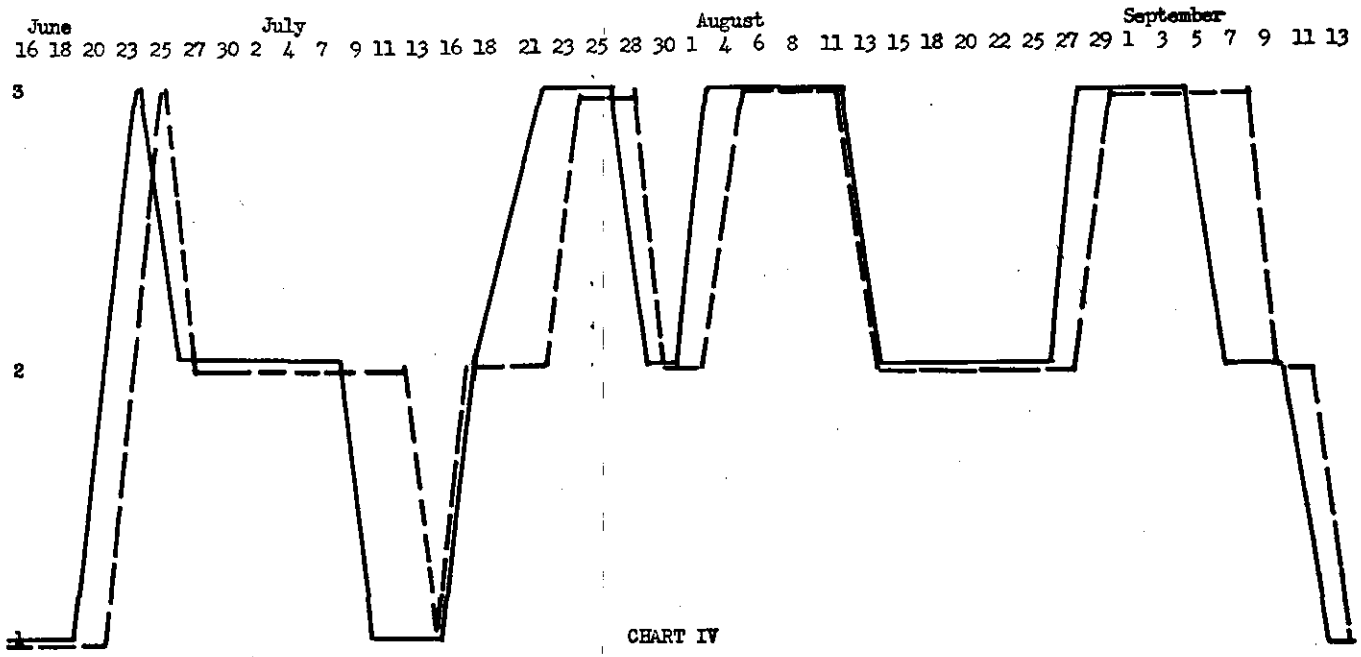


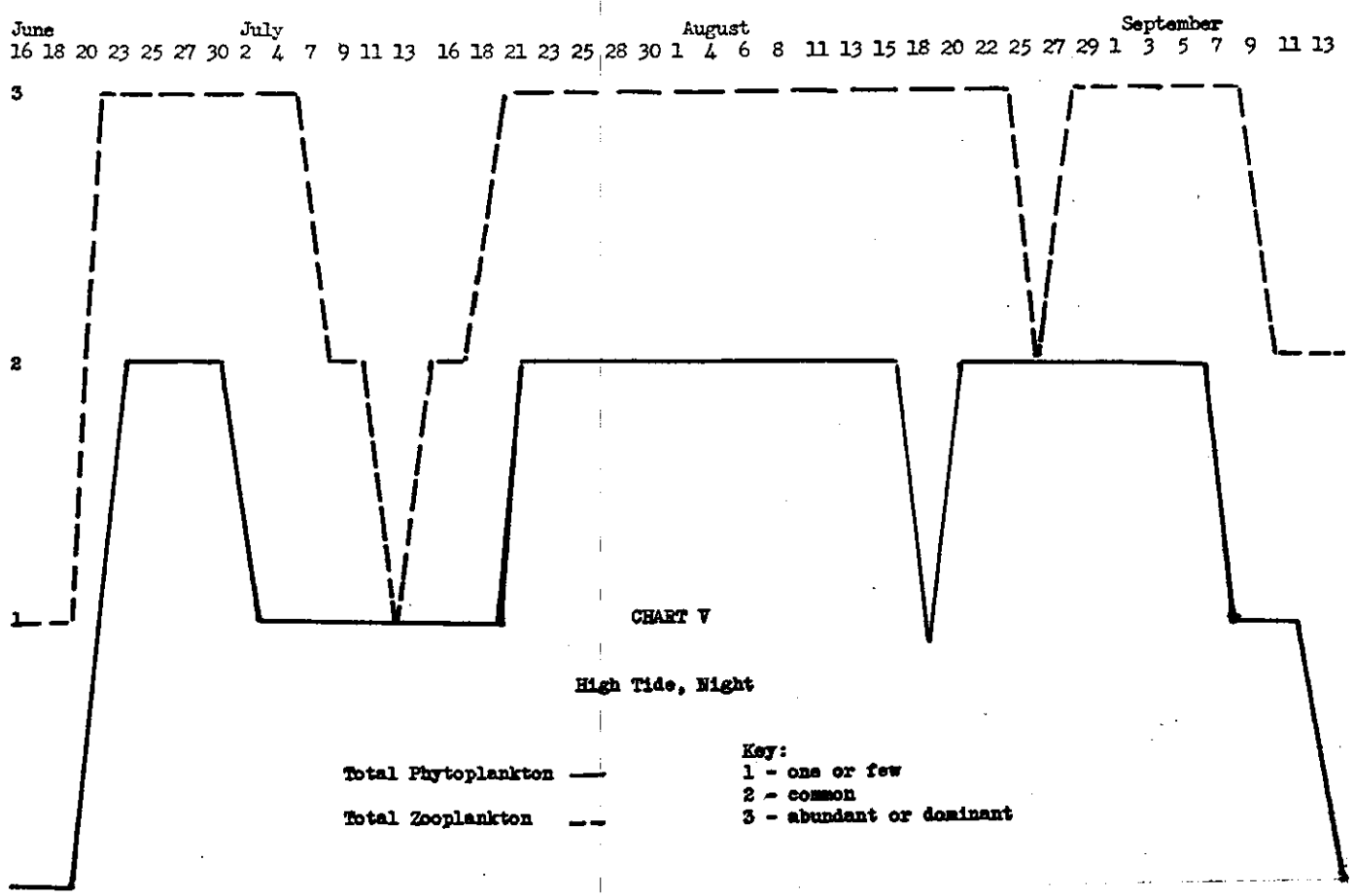
CHART IV

High Tide, Day

Total Phytoplankton ——

Total Zooplankton —·—·—

Key:
1 - one or few
2 - common
3 - abundant or dominant


June
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16 18 20 23 25 27 30 2 4 7 9 11 13 16 18 21 23 25 28 30 1 4 6 8 11 13 15 18 20 22 25 27 29 1 3 5 7 9 11 13
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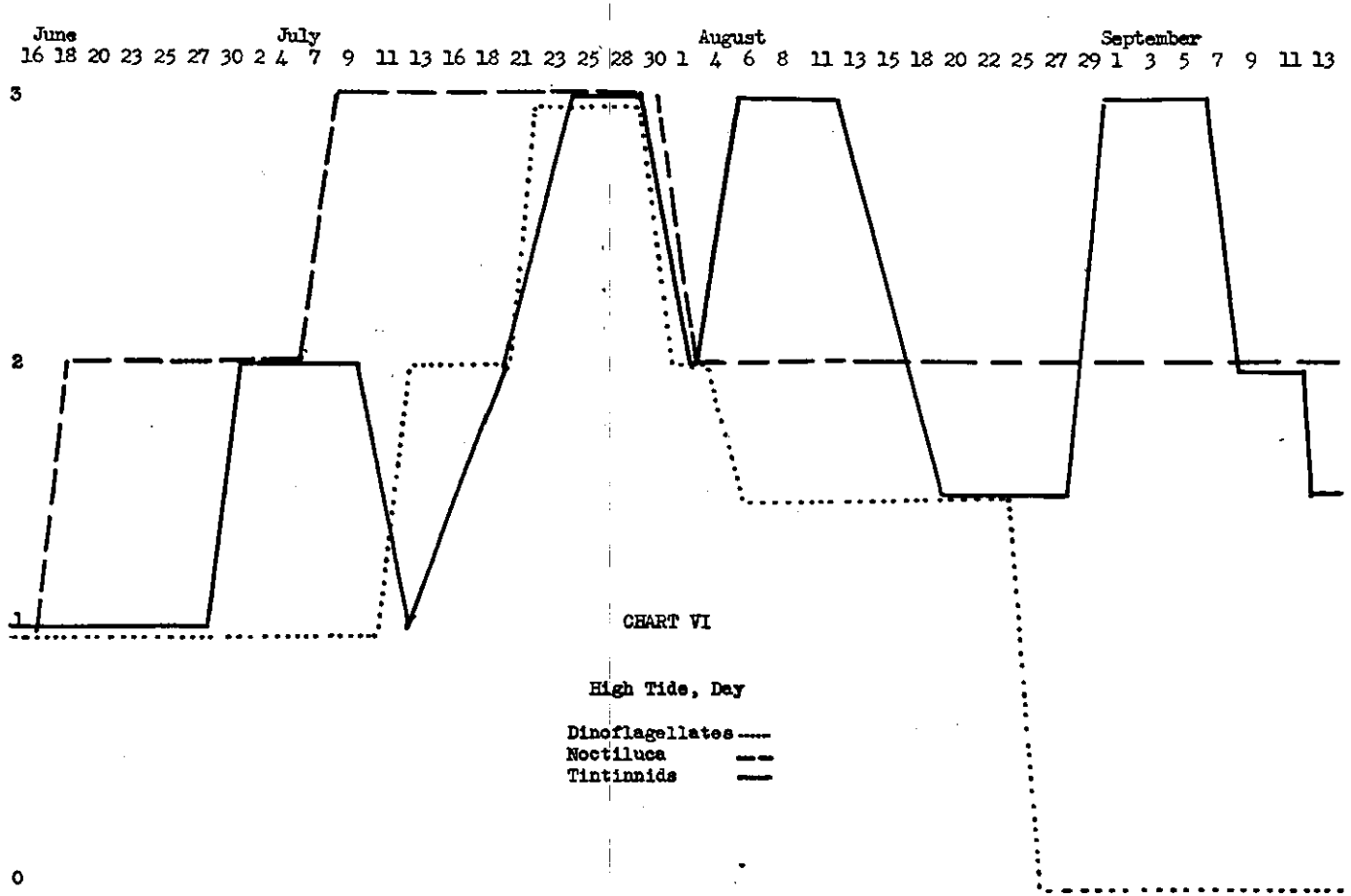
CHART V
High Tide, Night
Total Phytoplankton
Total Zooplankton
Key:
1 - one or few
2 - common
3 - abundant or dominant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16 18 20 23 25 27 30 2 4 7 9 11 13 16 18 21 23 25 28 30 1 4 6 8 11 13 15 18 20 22 25 27 29 1 3 5 7 9 11 13
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High Tide, Day
Dinoflagellates
Noctiluca
Tintinnids

CHART VI

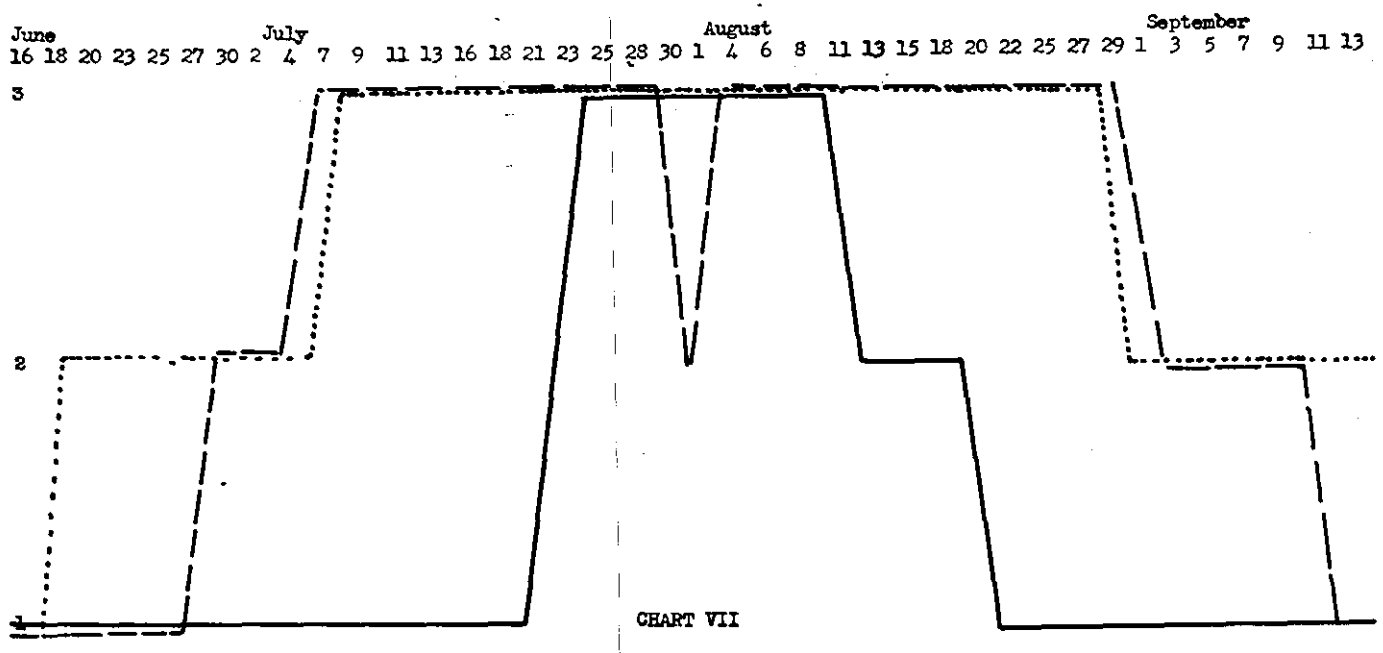

CHART VII

High Tide, Night

Dinoflagellates -----
Noctiluca — —
Tintinnids ——

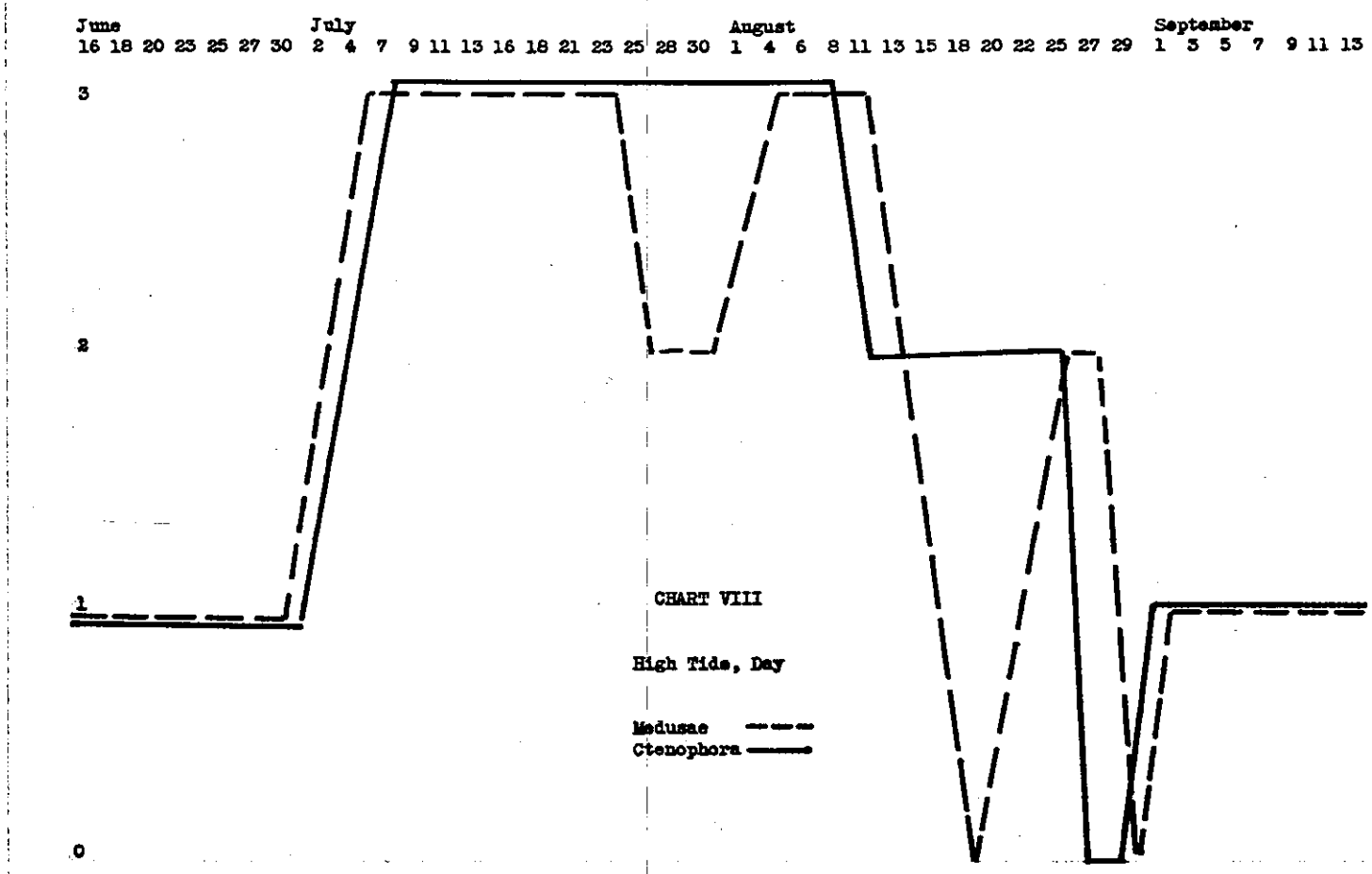
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CHART VIII
High Tide, Day
Medusae
Ctenophora

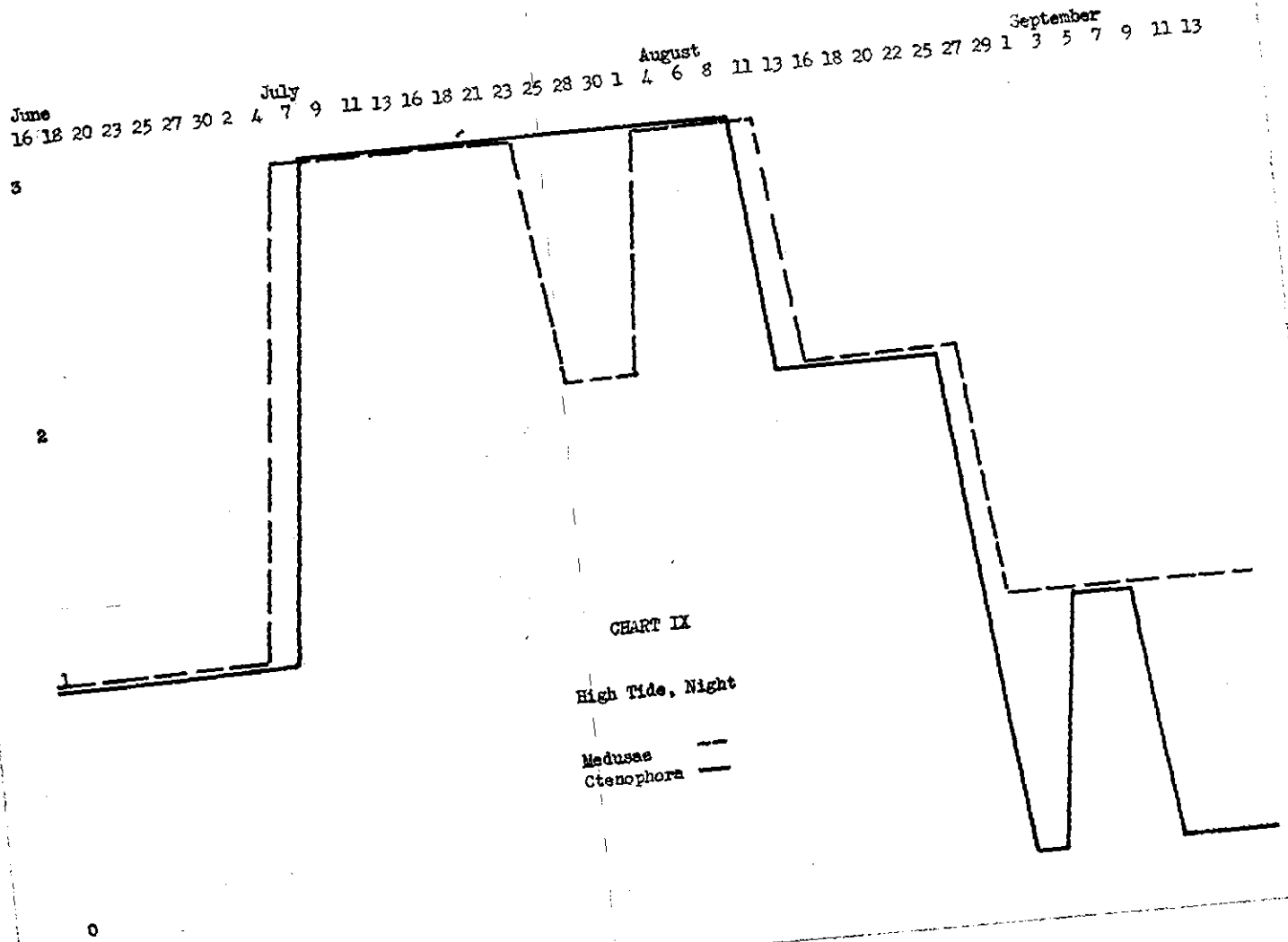
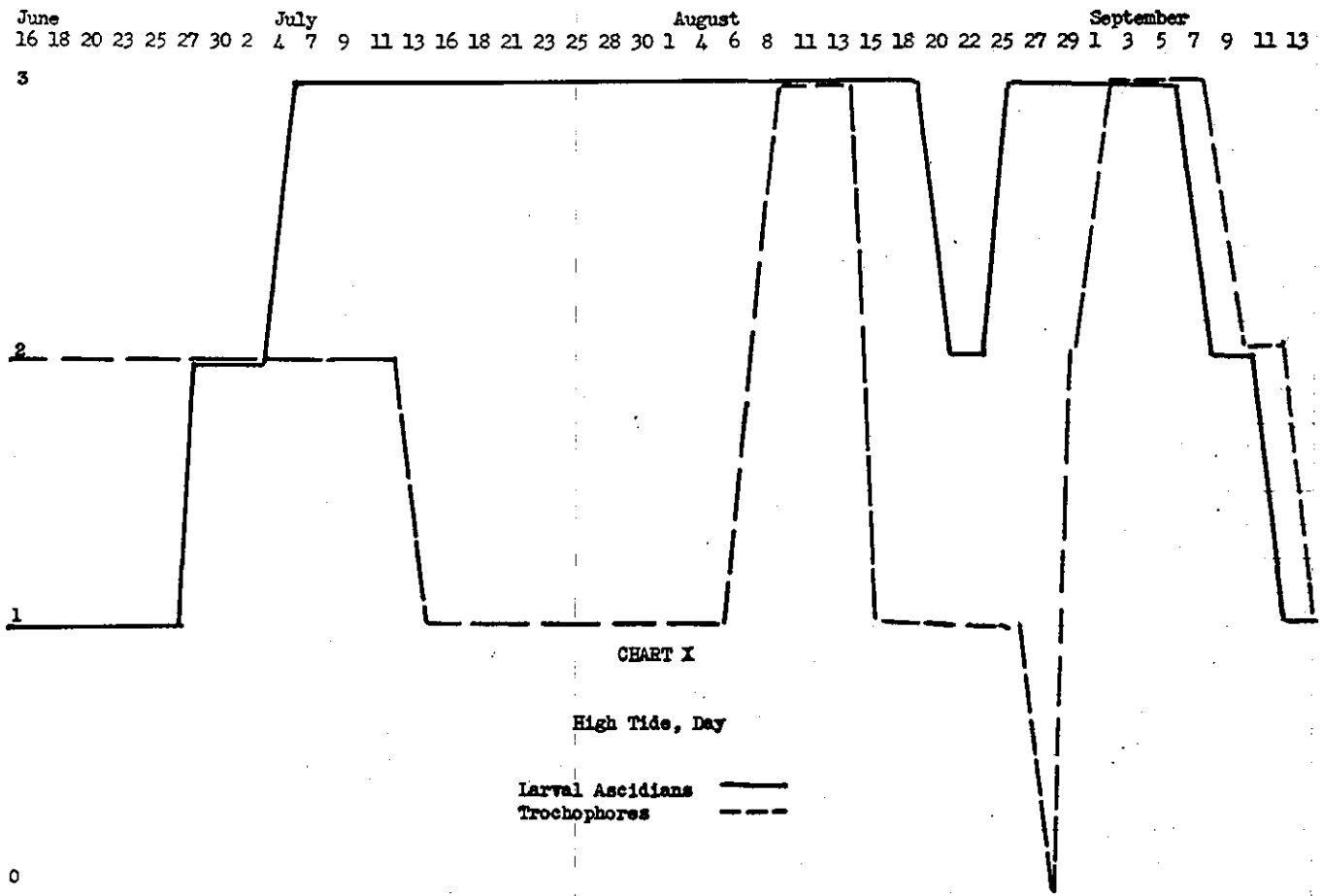


CHART IX

High Tide, Night

Medusae ——

Ctenophora ——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High Tide, Day
Larval Ascidians
Trochophores

CHART X

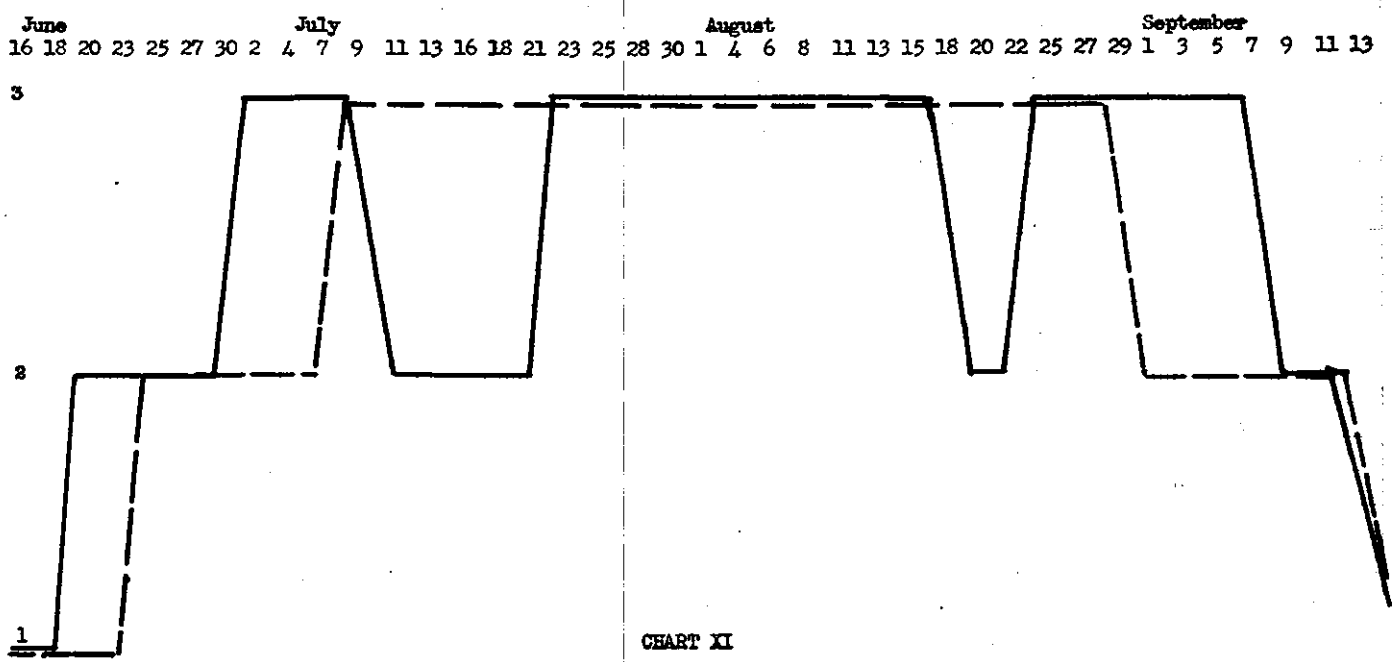
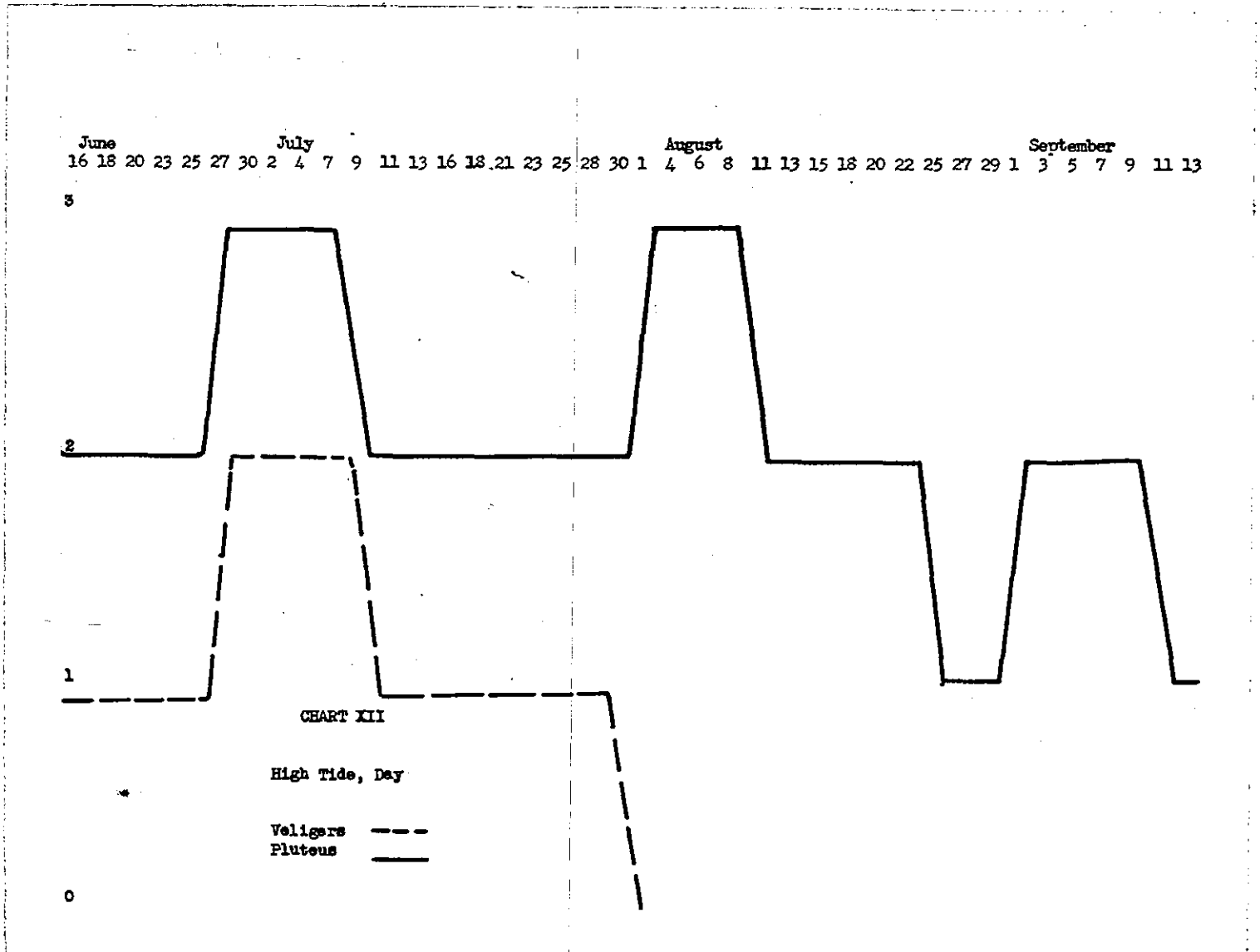


CHART XI

Low Tide, Night

Larval Ascidians ——
Trochophores — — —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High Tide, Day
Veligers
Pluteus

CHART XII

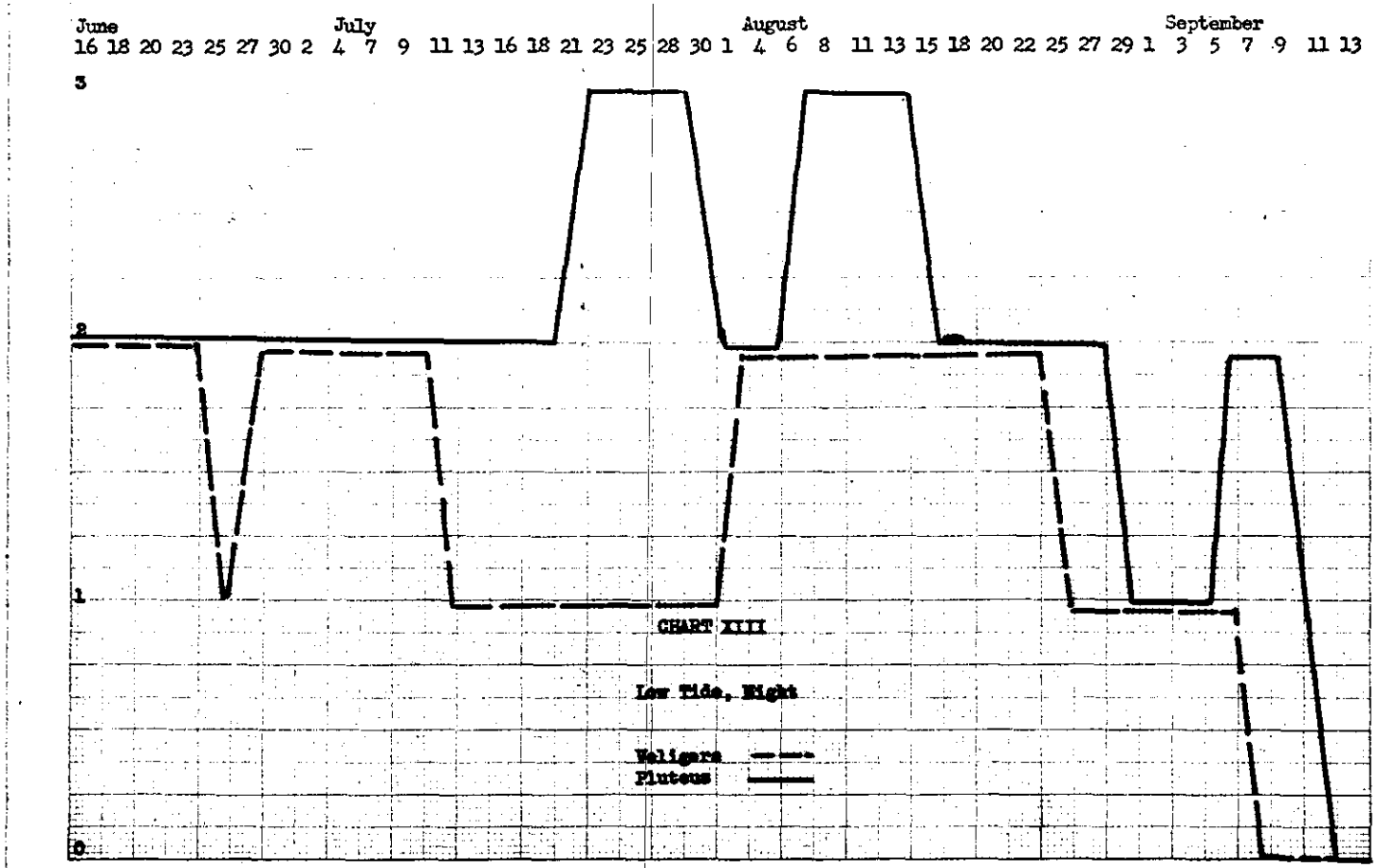
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CHART XIII
Low Tide, Night
Veligers
Pluteus

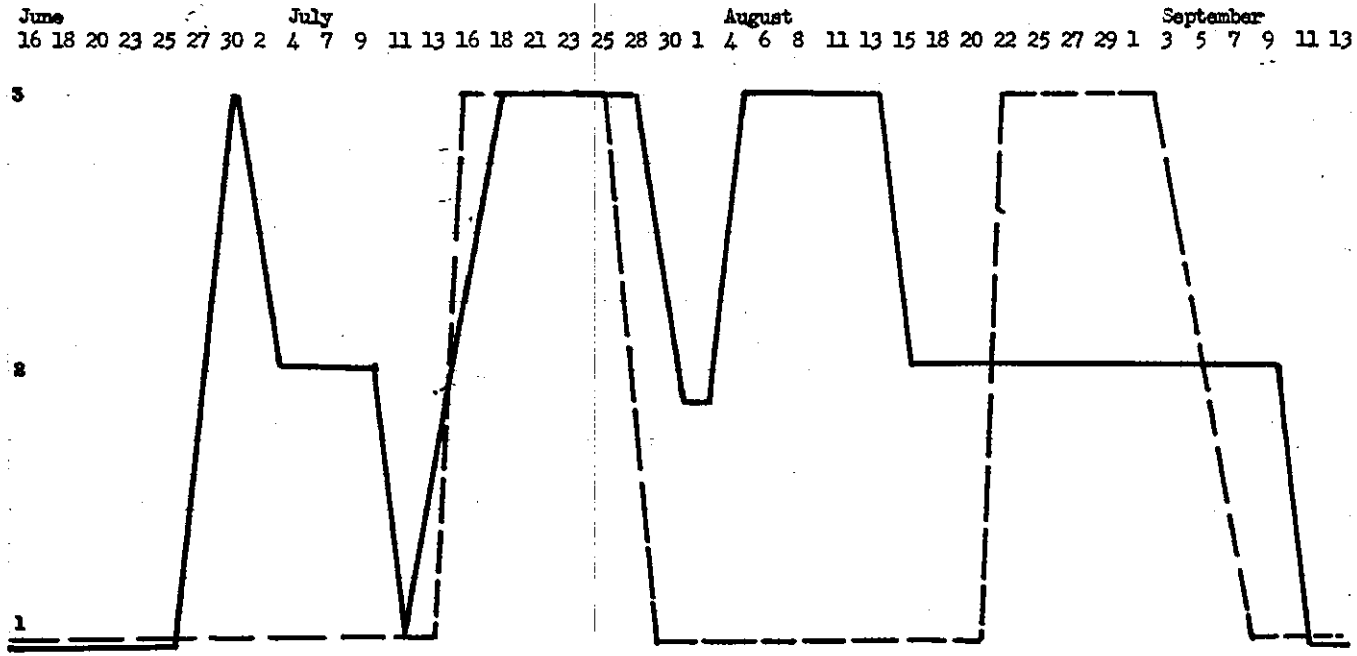

CHART XIV

High Tide, Day

Megalops — — —
Nauplei ——————

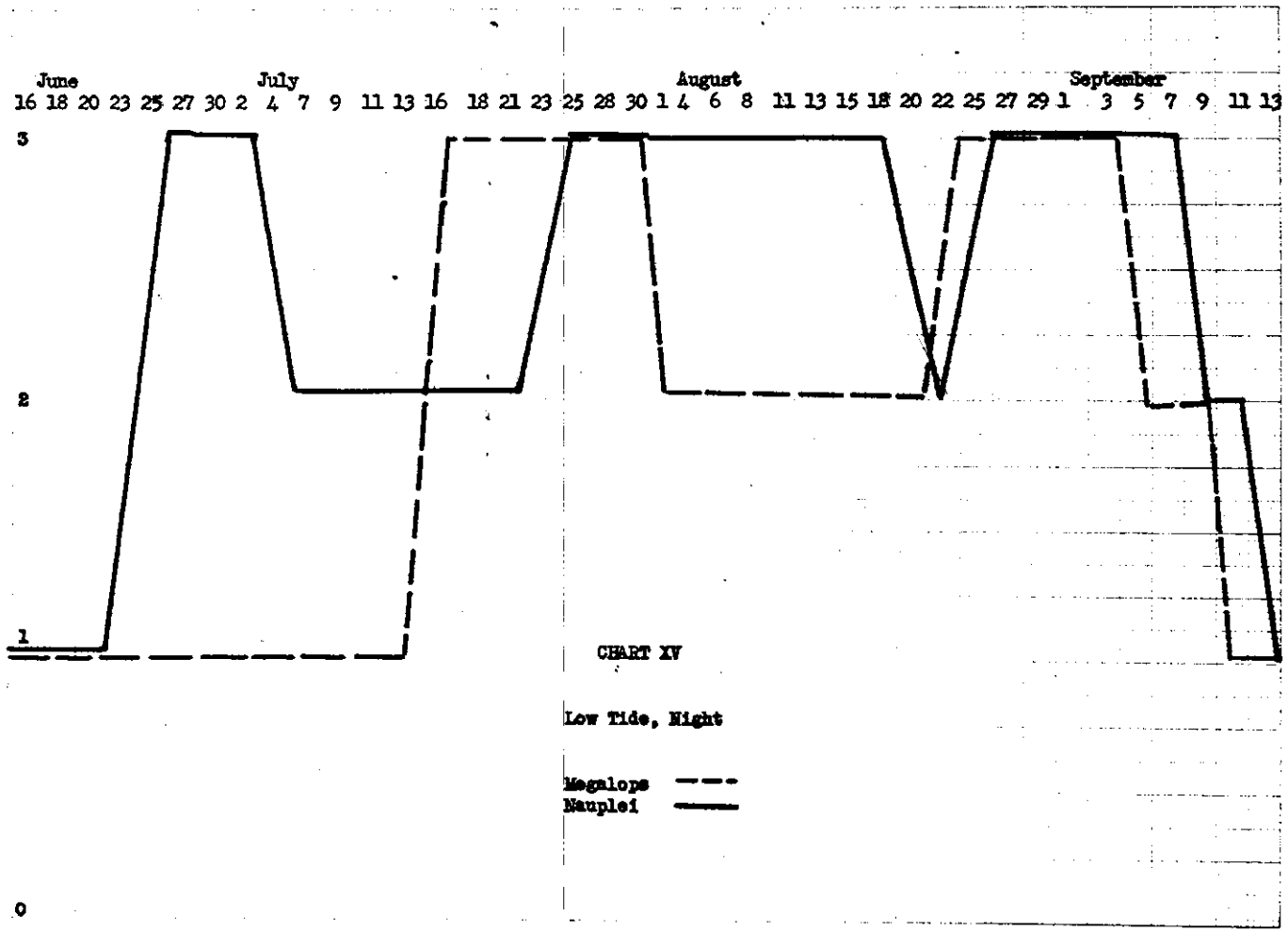

CHART XV

Low Tide, Night

Megalops ---
Nauplei ——

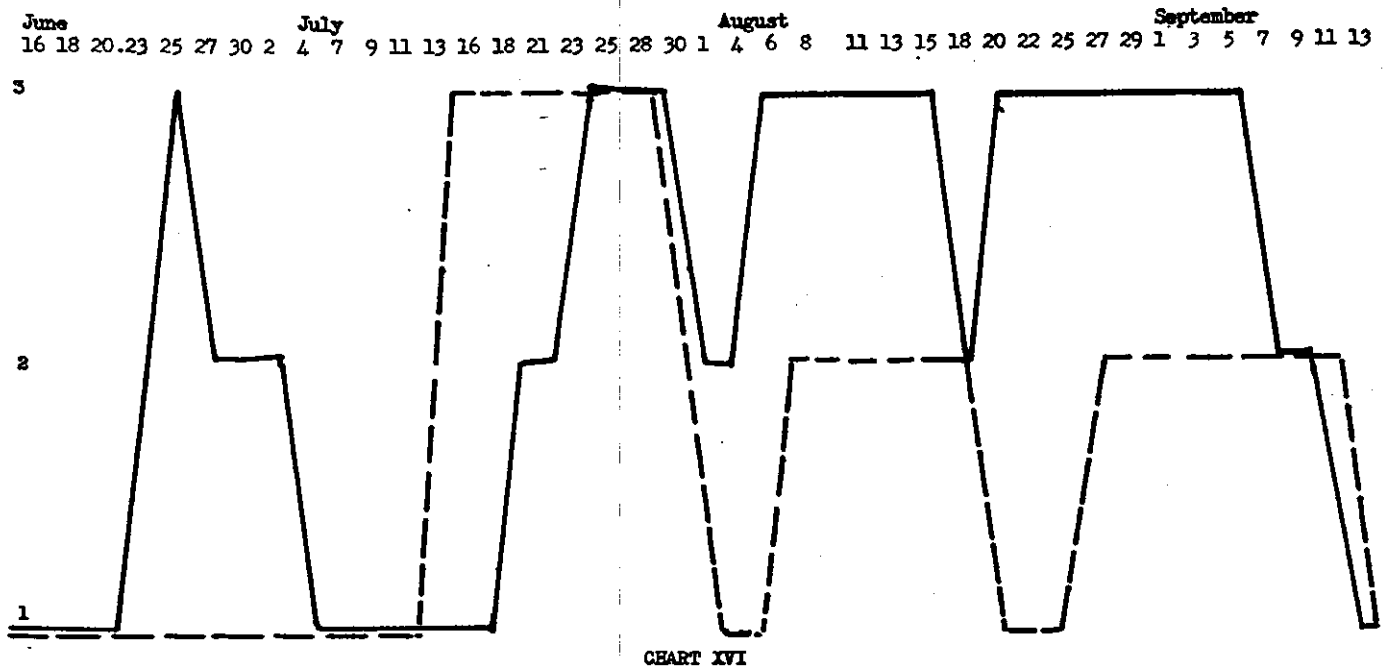

CHART XVI

High Tide, Day

Misc. Crustacean ---
Zoea ———

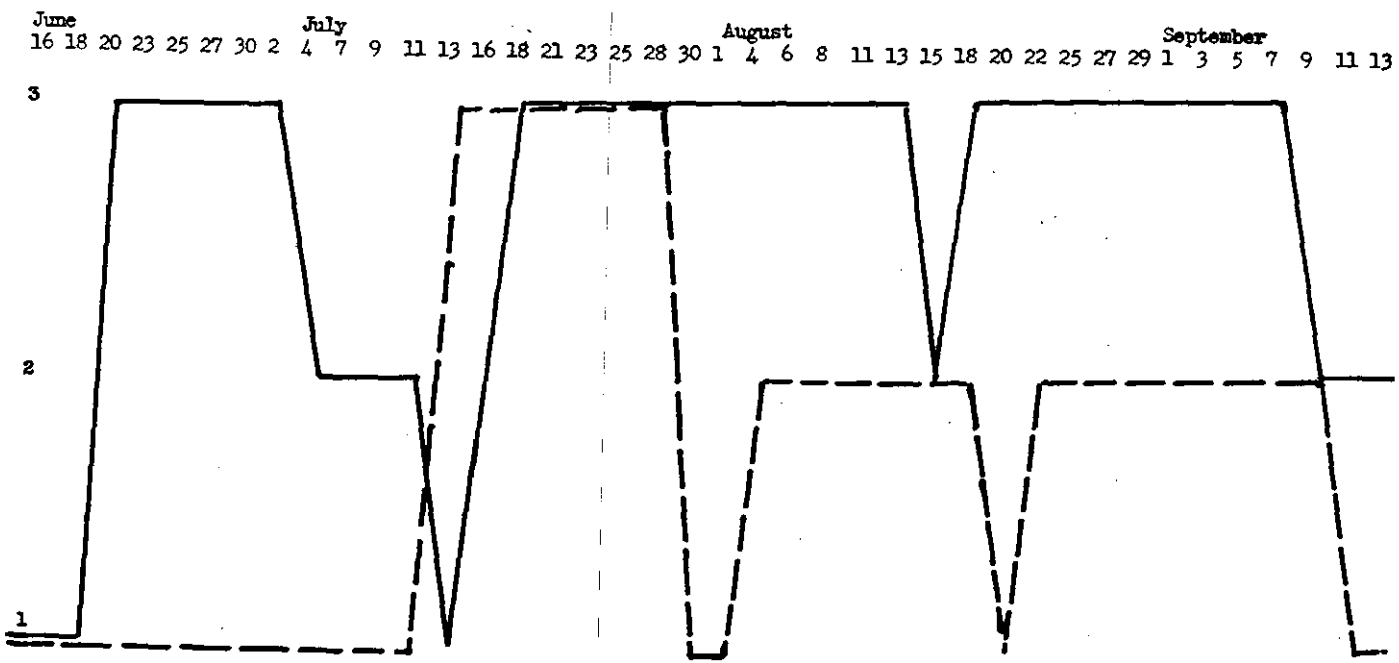

CHART XVII

Low Tide, Night

Misc. Crustacean Zoea

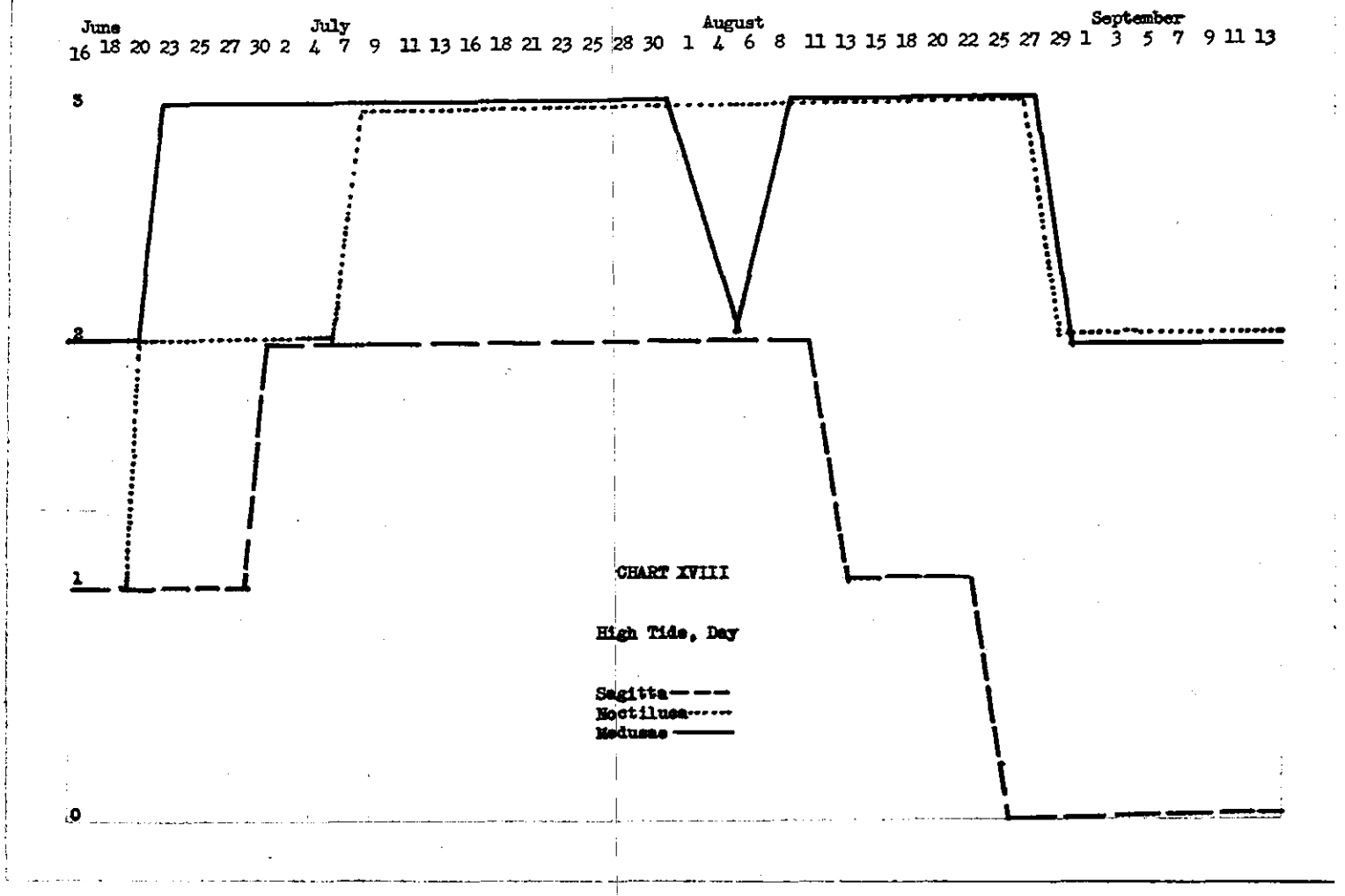
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CHART XVIII
High Tide, Day
Sagitta
Noctiluca
Medusae

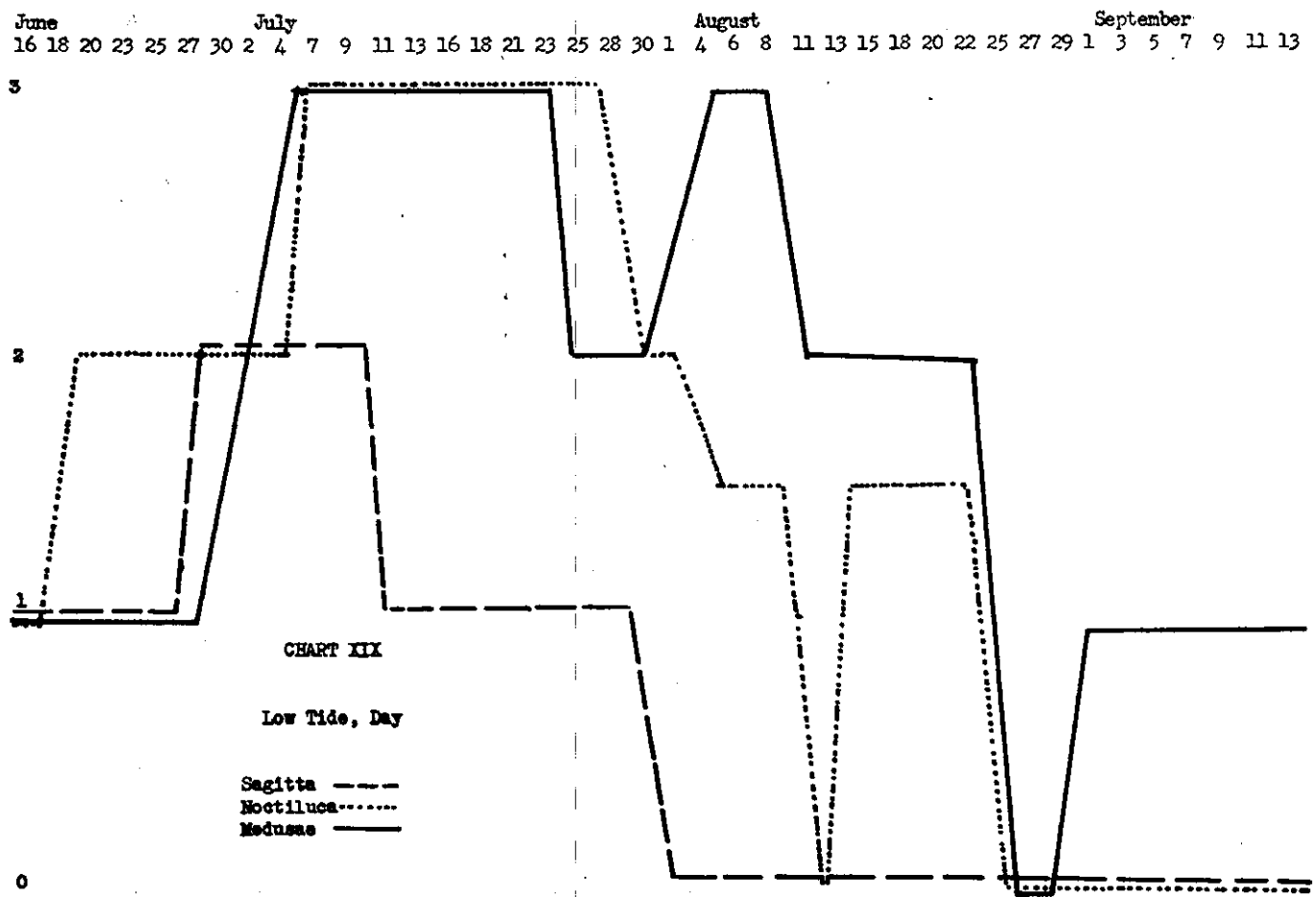
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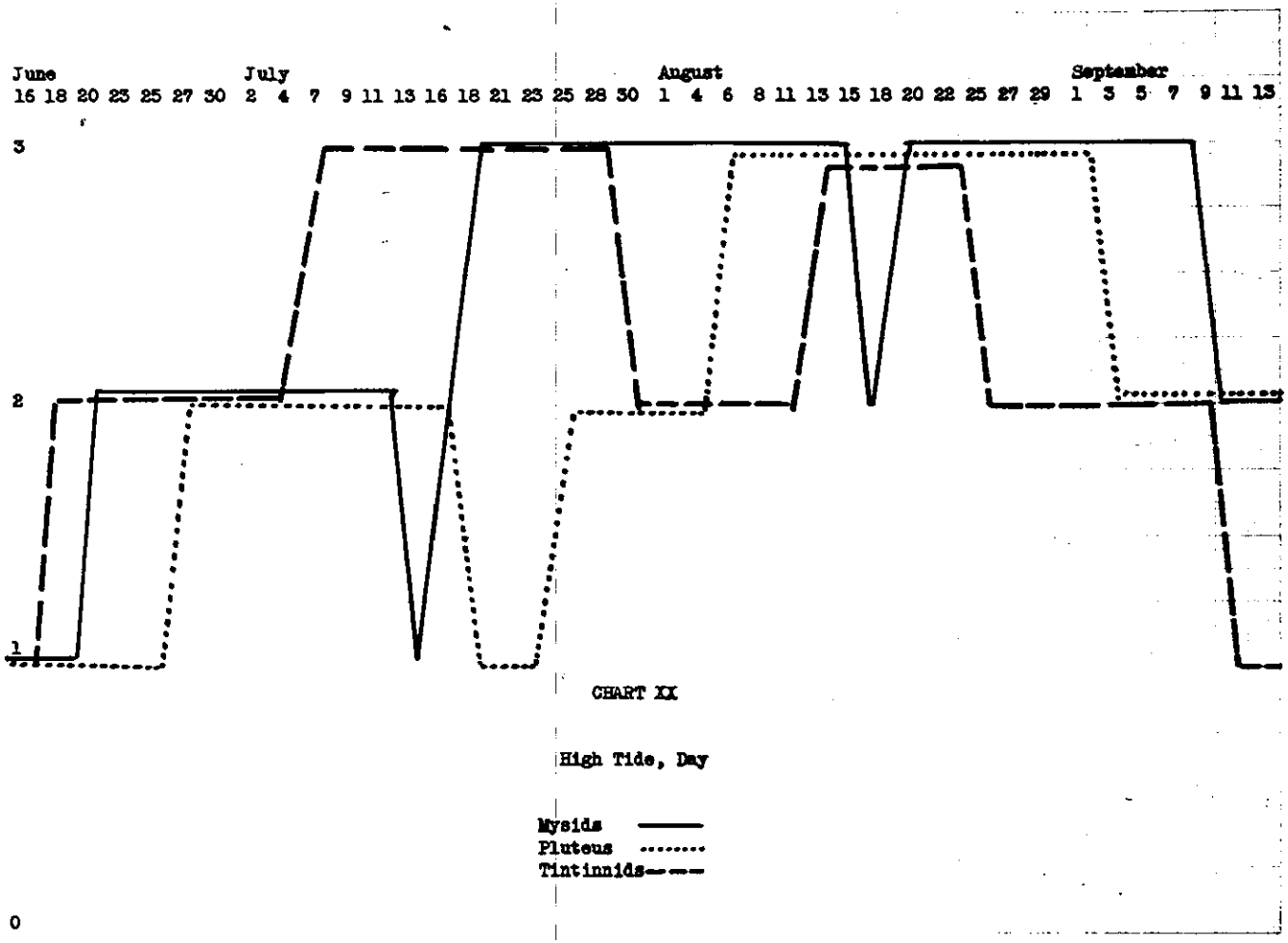
CHART XIX
Low Tide, Day
Sagitta
Noctiluca
Medusae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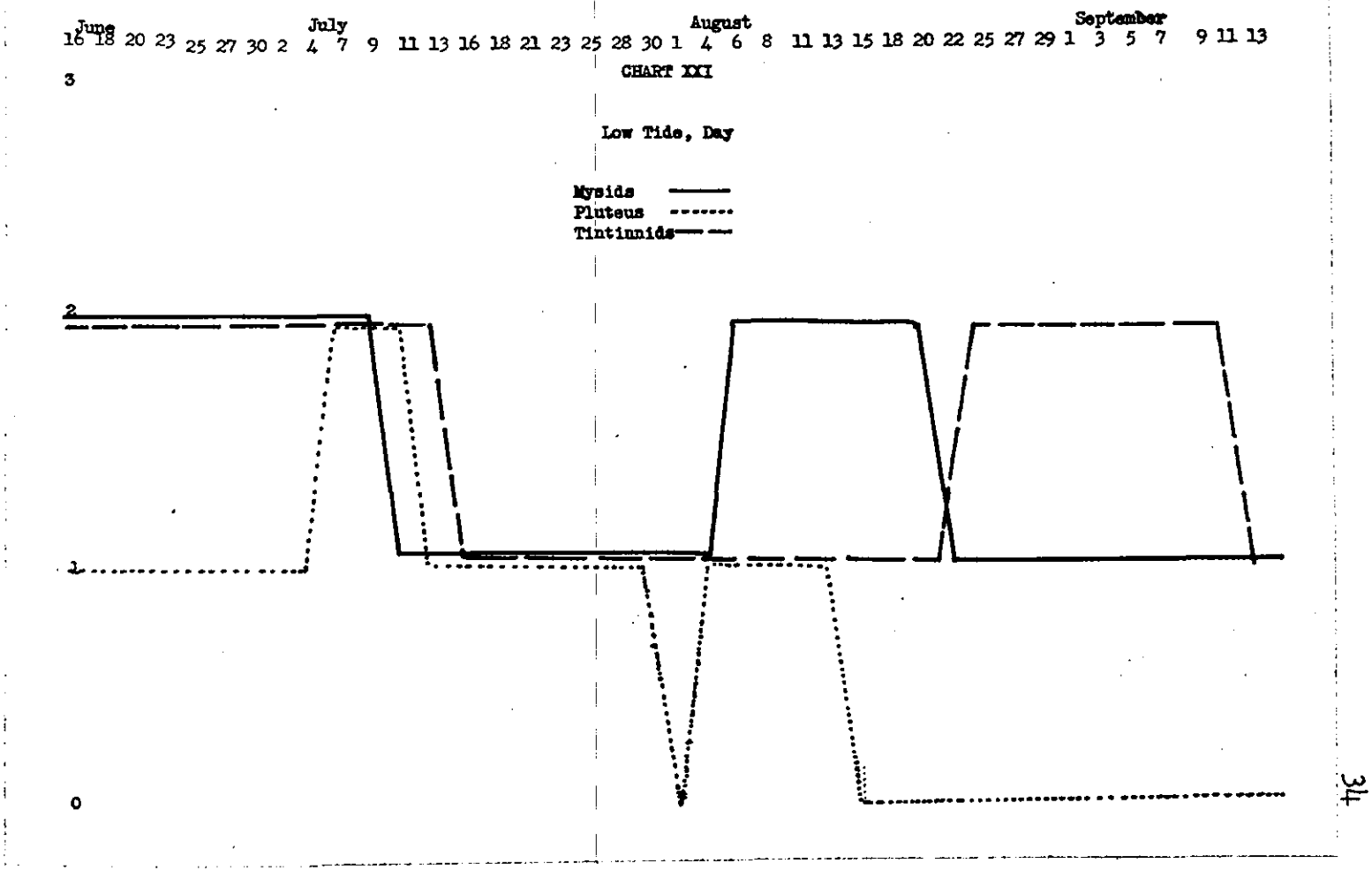
High Tide, Day
Mysids
Pluteus
Tintinnids

CHART XX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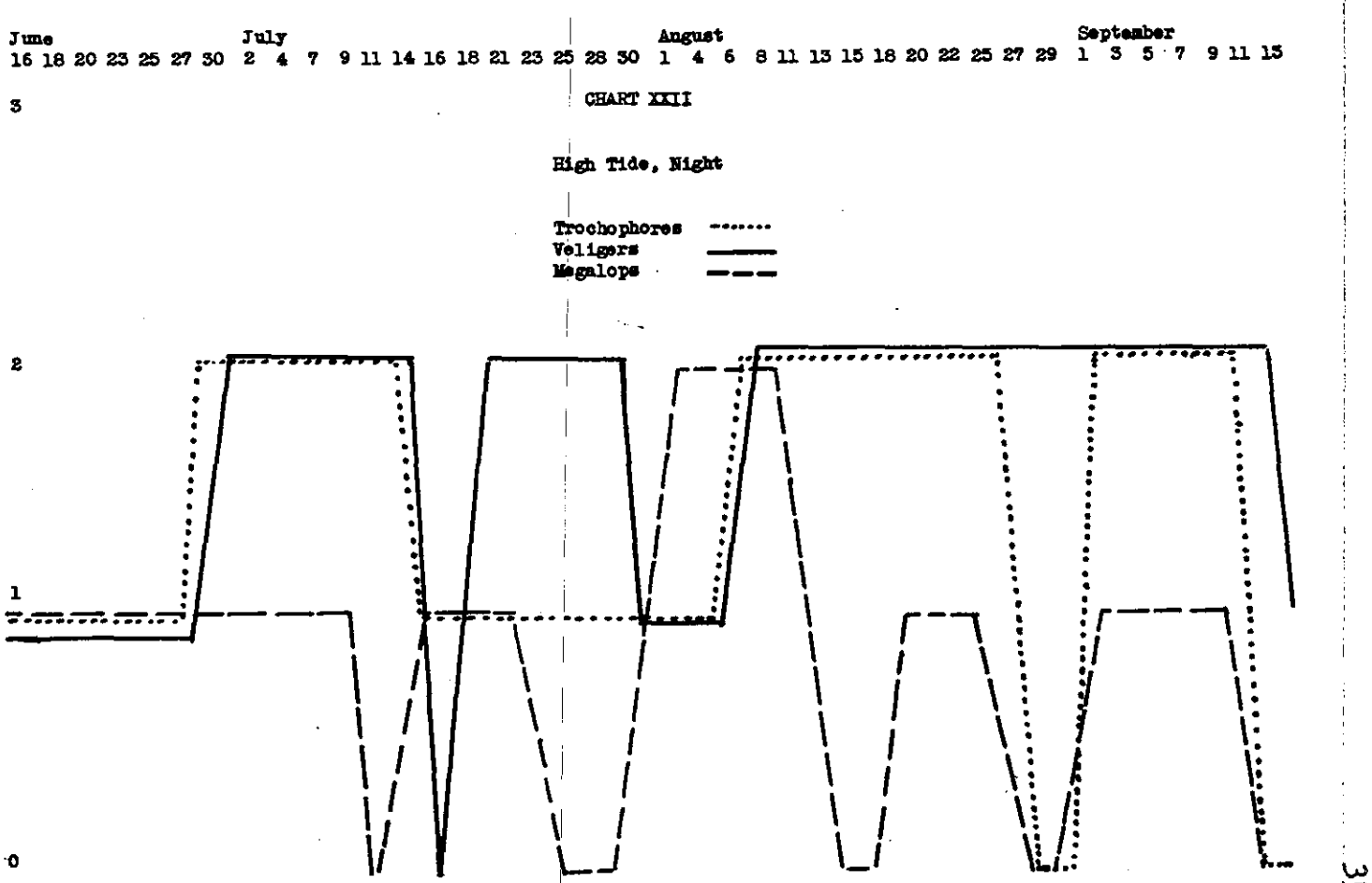
Low Tide, Day
Mysids
Pluteus
Tintinnids

CHART XXI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August
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CHART XXII
High Tide, Night
Trochophores
Veligers
Megalops

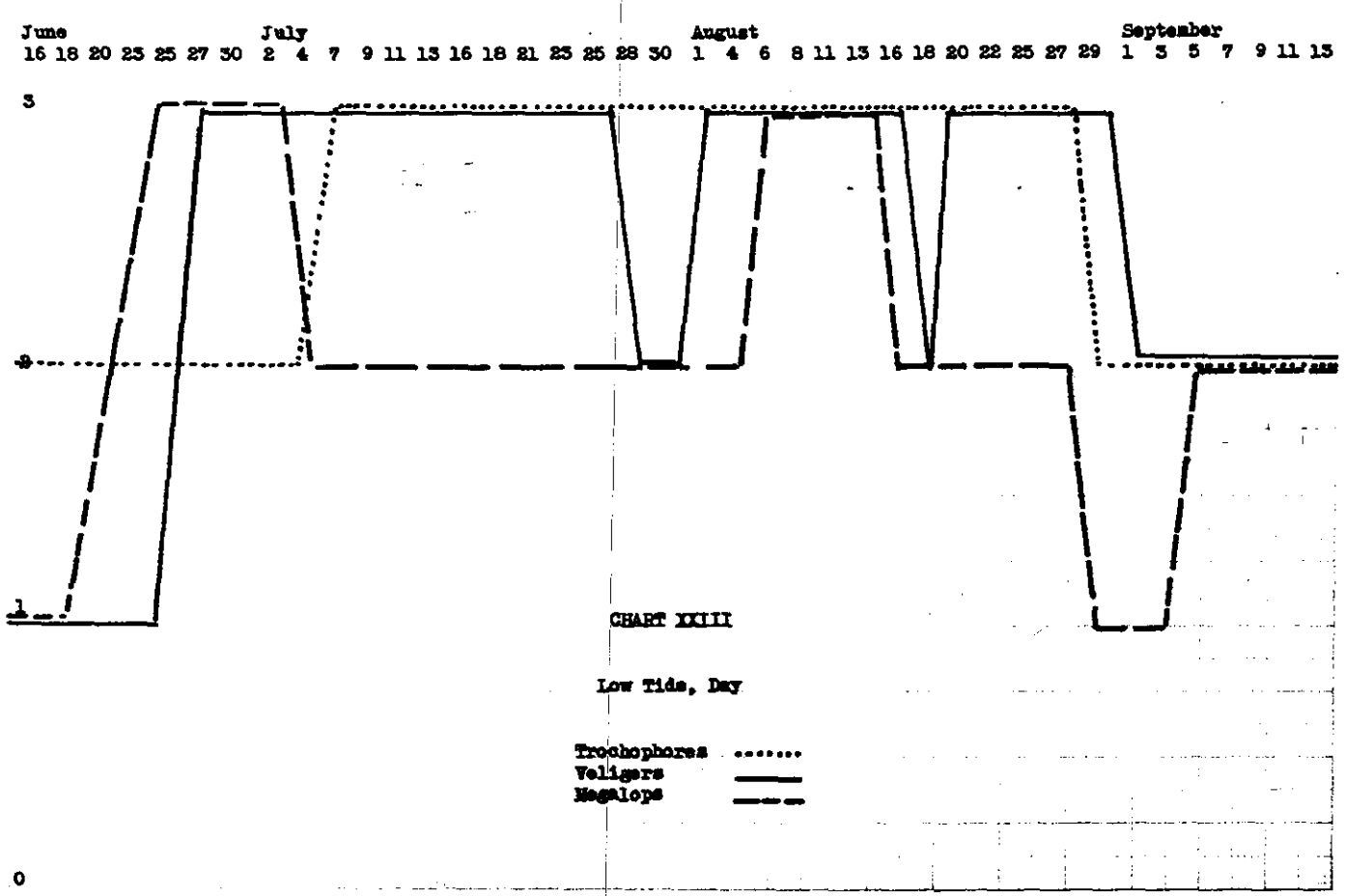


CHART XXIII

Low Tide, Day

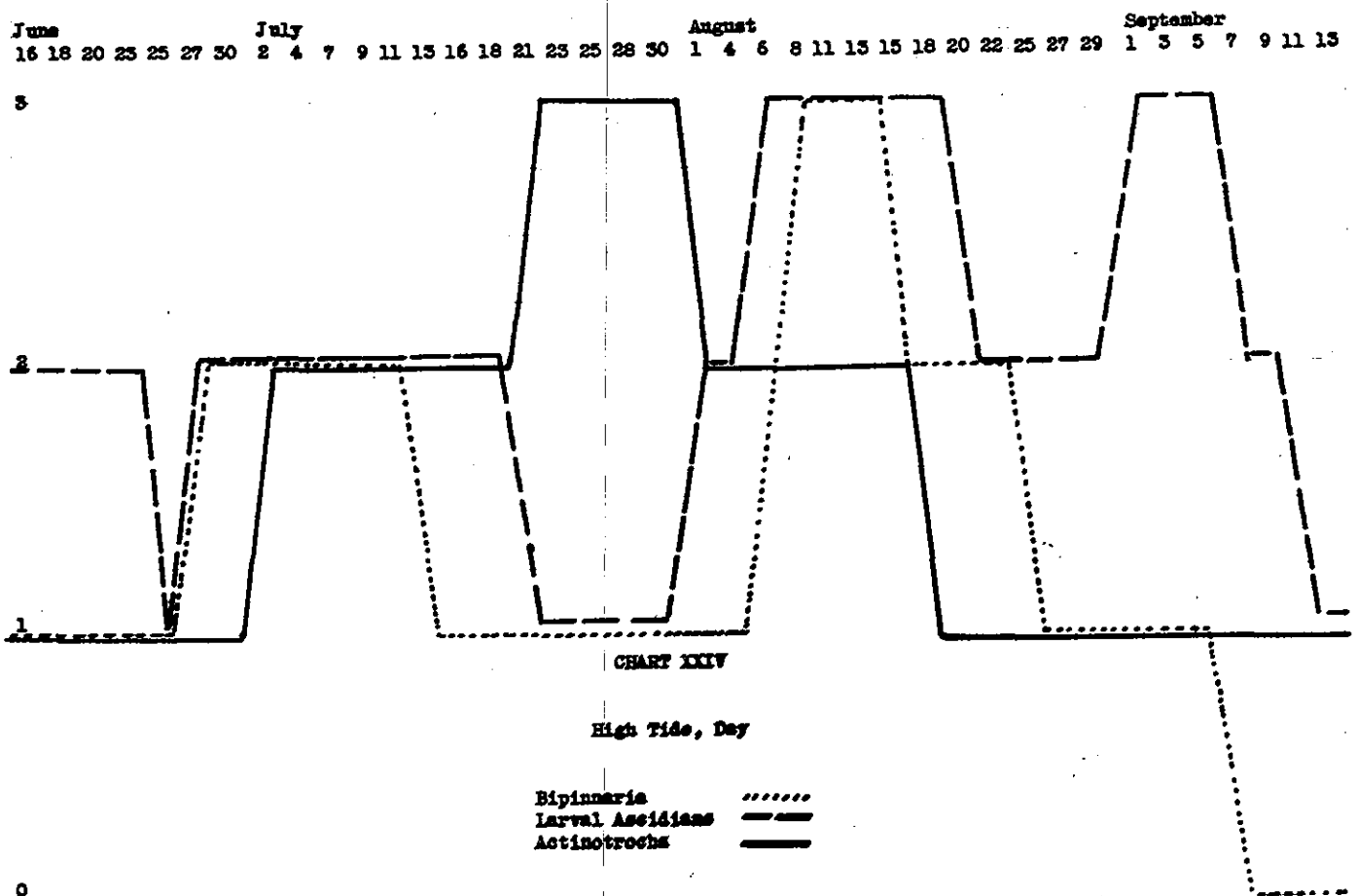


CHART XXIV

High Tide, Day

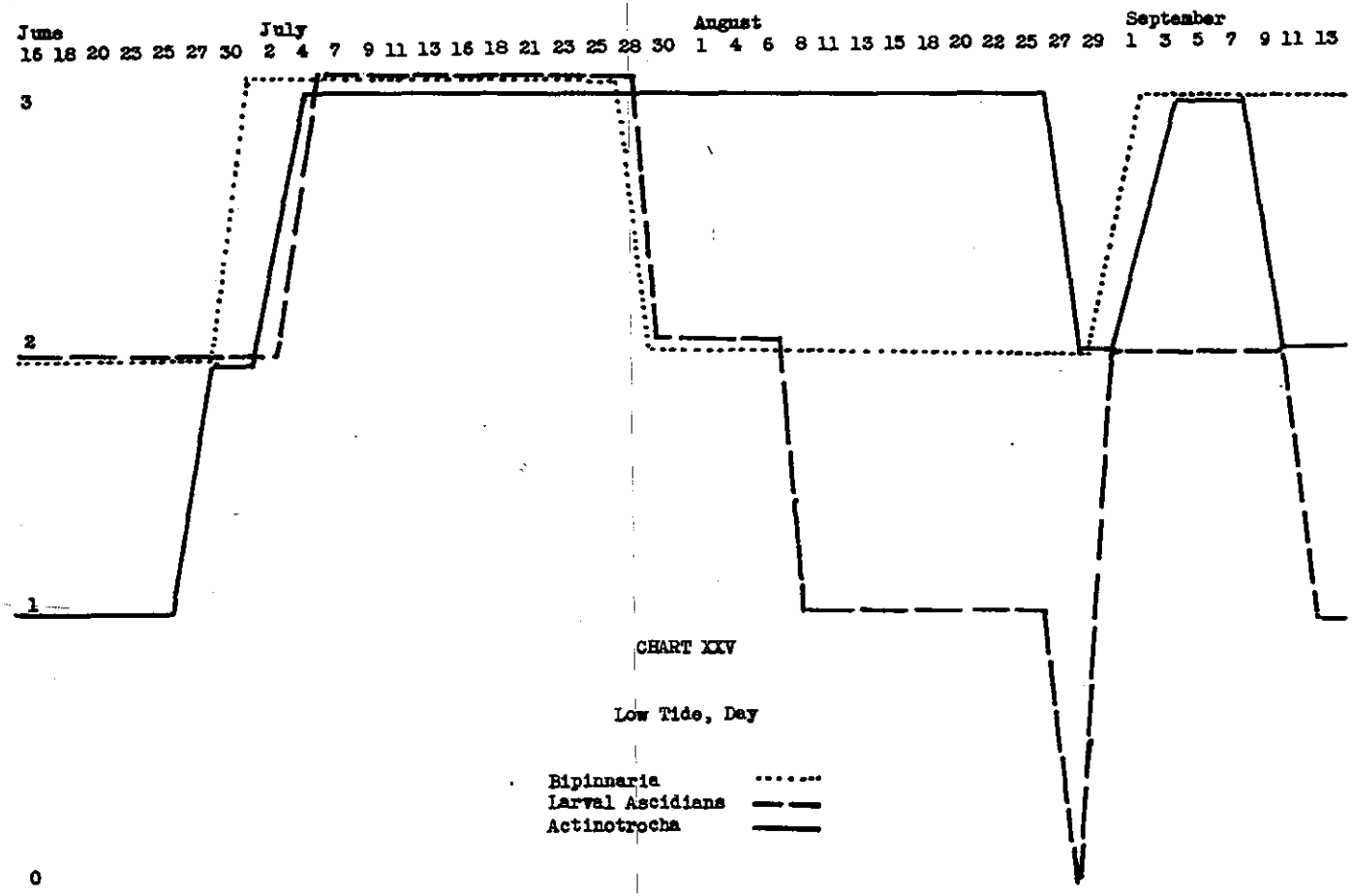


CHART XXV

Low Tide, Day

EXPLANATION OF TABLES

TABLE I, PAGES 41-43

Check sheets of the relative abundance of types of zooplankton collected during the summer of 1952. Total average for all daily collections regardless of the time of day or the heights of the tide. Figure 1 indicates relatively few organisms, figure 2 indicates they were plentiful, and figure 3 indicates that they were very abundant.

TABLE II, PAGES 44-52

Check sheets of the relative abundance of types of zooplankton collected in day and night samples, high tide, during the summer of 1952. Figure 1 indicates there were relatively few individuals present, figure 2 indicates there were many present, and figure 3 indicates that they were abundant.

TABLE III, PAGE 53

Check sheets of the relative abundance of types of phytoplankton collected during the summer of 1952; total averages regardless of tide or time of day. Figure 1 indicates few individuals present, figure 2 indicates there were many present, and figure 3 indicates that they were abundant.

TABLE IV, PAGE 54

Check sheets of the relative abundance of types of phytoplankton collected by day as compared with types collected at night on the same date. Figure 1 indicates few individuals present, figure 2 indicates there were many present, and figure 3 indicates that they were abundant.

TABLE V, PAGES 55-63

Check sheets of the relative abundance of types of zooplankton collected at high tide as compared with types collected at low tide on the same day. Figure 1 indicates relatively few organisms present, figure 2 indicates they were plentiful, and figure 3 indicates that they were very abundant.

TABLE VI, PAGE 64

Check sheets of the relative abundance of types of zooplankton collected during the four seasons of the year. Figure 1 indicates there were few individuals present, figure 2 indicates individuals were common, and figure 3 indicates that they were very abundant.

TABLE I

Animals occuring in plankton samples from Tomales Bay during the summer of 1952

Organism	JUNE							JULY				
	16	18	20	23	25	27	30	2	4	7	9	11
Protozoa												
Dinoflagellates	1		1	1		1	1	1	2	2	2	3
Noctiluca	1		1	1	1	2	2	2	2	1	1	1
Tintinnids												
Formaniferama				1		1						
Coelenterata												
Medusae	1	1	1	1	1	1	2	3	3	3	3	2
Ctenophora	2	1	1	3	3	3	3	3	3	2	2	1
Turbellaria				1	2	2	2	2	2	2	1	1
Chaetognatha			1	1	1	1	1	2	3	3	3	3
Nematoda					1	2	1	1	1	1	1	1
Annellda												
Young and Adults			1	1	1	2	3	3	2	2	2	1
Trochophores			1	1	1	1	1	1	2	2	2	2
Arthropoda												
Misc. Crustaceae*	2	2	2	2	2	3	3	3	2	2	2	2
Nauplei					1	2	1	1	1	1	1	1
Cyprids						1	2	2	2	1	2	2
Zoea									1	1	1	1
Megalops				1	2	2	2					
Mollusca												
Veligers						1	1	1	1			
Echinodermata												
Bipinnaria							1					
Pluteus	1	1	1	1	1	1	1	2	2	2	2	1
Appendicularia	1	1	2	2	2	2	2	2	2	2	2	2
Pisces												
Immature				1		1	1					

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE I, Cont'd.

Animals occuring in plankton samples from Tomales Bay during the summer of 1952

Organism	JULY								AUGUST			
	14	16	18	21	23	25	28	30	1	4	6	8
Protozoa												
Dinoflagellates	3	3	2	2	2	2	2	1	1	1		
Noctiluca	3	3	3	3	2	2	2	3	3	3	3	3
Tintinnids	3	2	3	2	2	2	2	1	2	3	2	
Formaniferams	1	1	1									
Coelenterata												
Medusae	2	1	1	1	1							
Ctenophora												
Turbellaria			1	1	1	2	2	2	2	2	1	1
Chaetognatha	3	3	3	3	3	2	2	2				
Nematoda	1	1	1									
Annelida												
Young and Adults	2	2	2	2	1	1	1					
Trochophores	1	1	1	1								
Arthropoda												
Misc. Crustaceae*	3	3	3	2	2	2	2	1	1	1	1	1
Nauplei						1	1	1	1			
Cyprids	3	3	3	1	1	1						
Zoea	3	3	3	2	2	2	2	1	1	1	1	
Megalops	3	3	3	3	3	2	2	2	2	2		
Mollusca												
Veligers						1	1	1	1	2	2	2
Echinodermata												
Bipinnaria	2	2	2	2	2	2	1	1				
Pluteus	1	1	1	1	1	1						
Appendicularia	3	3	3	3	2	2	2	2	2	2	2	2
Pisces												
Immature												

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE I, Cont'd.

Animals occuring in plankton samples from Tomales Bay during the summer of 1952

Organism	AUGUST									SEPTEMBER		
	11	13	15	18	20	22	25	27	29	1	3	5
Protozoa												
Dinoflagellates	2	1	2	2	2	2	2	1	1	1	1	1
Noctiluca	3	1	1	1	1	1	1	1	1			
Tintinnids		2	2	2	2					1	1	1
Formaniferams												
Coelenterata												
Medusae				1	2	2	2	2	1	1		
Ctenophora					1	1	1	1			1	
Turbellaria	1	1	1	1	2	2	2	2				
Chaetognatha												
Nematoda											2	2
Annelida												
Young and Adults	1	1	1	2	3	3	3	2	1	1	1	1
Trochophores												
Arthropoda												
Misc. Crustaceae*	1	1	2	2	3	3	3	2	2	1	1	1
Nauplei			1	1	1	3	3				1	1
Cyprids					3	3	3	3		1		
Zoea	1	1	1	1	3	3	3					
Megalops												
Mollusca												
Veligers	2	1	1	1	1					2	2	2
Echinodermata												
Bipinnaria			1	1	2	2	2	2	2	2	1	1
Pluteus				1	1	1	1	1	1			
Appendicularia											3	3
Pisces												
Immature												

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE II

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
During the day and night collections

Organism	JUNE 16		JUNE 18		JUNE 20		JUNE 23	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Protozoa								
Dinoflagellates	1	1	1	2	1	2	1	2
Noctiluca	1		1		1		1	
Tintinnids					1	3	1	3
Formaniferams					1	1	1	3
Coelenterata								
Medusae	1	2	1	2	1	3	1	1
Ctenophora								
Turbellaria				1	1	1	1	1
Chaetognatha								
Nematoda		1	1	1	1		1	1
Annelida								
Young and Adults			1	2	1	2	1	2
Trochophores					1	2	1	2
Arthropoda								
Misc. Crustaceae*	2	2	2	2	2	2	2	2
Nauplei		2		2				
Cyprids		2		2		2		2
Zoea		2		2				
Megalops		2		2	1	2	2	3
Mollusca								
Veligers					1	1		1
Echinodermata								
Bipinnaria					1			
Pluteus	1	1	1	2	1			
Appendicularia	1	1	2	2	2	2	1	2
Pisces								
Immature								

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE II, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
During the day and night collections

Organism	JUNE 25		JUNE 27		JUNE 30		JULY 2	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Protozoa								
Dinoflagellates	1	2	1	2	1	2	1	2
Noctiluca	1		2	3	2	3	2	3
Tintinnids	1	3		2		2		2
Formaniferams	1	1						
Coelenterata								
Medusae	1	1	1	1	2	3	3	3
Ctenophora								
Turbellaria	1	2	2	2	2	2		
Chaetognatha								
Nematoda	1		1	1	2	2	2	2
Annelida								
Young and Adults	1	2	2	2	2	2	2	2
Trochophores	1	2	1	1	1	2	2	3
Arthropoda								
Misc. Crustaceae*	2	3	3	3	3	3	3	3
Nauplei				3		3		3
Cyprids	1	2		3		3		3
Zoea				3		3		3
Megalops	2	3	3	3	2	2	1	1
Mollusca								
Veligers	1	2						
Echinodermata								
Bipinnaria								
Pluteus								
Appendicularia	1	2	2	2	2	2	2	2
Pisces								
Immature								

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE II, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
During the day and night collections

Organism	JULY 4		JULY 7		JULY 9		JULY 11	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Protozoa								
Dinoflagellates	1	2	2	3	2	3	2	3
Noctiluca	2	3	2	3	2	3	2	3
Tintinnids		2		2		1		1
Formaniferams								
Coelenterata								
Medusae	3	3	3		1	1	1	2
Ctenophora								
Turbellaria					1	2	1	2
Chaetognatha								
Nematoda	2	2	2	2	1	2	1	2
Annelida								
Young and Adults	2	2	1	1	1	2	1	1
Trochophores	2	3	2	2	1	1		1
Arthropoda								
Misc. Crustaceae*	3	3	3	3	3	3	3	3
Naupleí		3		2			1	1
Cyprids		2		2		1	1	1
Zoea		3		2			1	
Megalops							1	2
Mollusca								
Veligers								
Echinodermata								
Bipinnaria								
Pluteus							1	1
Appendicularia	2	3	2	3	2	3	2	3
Pisces								
Immature								

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE II, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
During the day and night collections

Organism	JULY 14		JULY 16		JULY 18		JULY 21	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Protozoa								
Dinoflagellates	2	3	2	3	2	3	3	3
Noctiluca	3	3	3	3	3	3	3	3
Tintinnids		1		1		1		2
Formaniferams								
Coelenterata								
Medusae	1	2	1	2	1	2	1	2
Ctenophora								
Turbellaria	1	2	1	2				1
Chaetognatha								1
Nematoda	1	1						
Annelida								
Young and Adults		1	1	1	1	2		1
Trochophores								2
Arthropoda								
Misc. Crustaceae*	3	3	3	3	3	3	3	3
Nauplei	1	2	1	2	1	2	1	3
Cyprids	1	2	1	2	1	2	1	3
Zoea							1	3
Megalops	2	2	2	3	2	3	2	3
Mollusca								
Veligers		1		1		1	1	2
Echinodermata								
Bipinnaria		1		1		1	1	2
Pluteus	1	1	1	1	2	3		
Appendicularia	2	3	2	3	2		1	2
Pisces								
Immature								

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE II, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
During the day and night collections

Organism	JULY 23		JULY 25		JULY 28		JULY 30	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Protozoa								
Dinoflagellates	3	3	3	3	3	3	2	2
Noctiluca	3	3	2	3	2	2	2	2
Tintinnids	2	2	2	2		2	1	
Formaniferams								
Coelenterata								
Medusae		1		1	1	2		1
Ctenophora								
Turbellaria		1		1		1		
Chaetognatha		1		1		1		
Nematoda								
Annelida								
Young and Adults								
Trochophores	2	2	2	3	1	3		
Arthropoda								
Misc. Crustaceae*	3	3	3	3	3	3	3	3
Nauplei	1	3	1					
Cyprids	1	3	1					
Zoea	1	3	1					
Megalops	2	2	1	1	1	1	1	2
Mollusca								
Veligers		1		1		1	1	2
Echinodermata								
Bipinnaria		1		1				
Pluteus							1	1
Appendicularia	1	2	1	2	2	3	3	3
Pisces								
Immature								

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE II, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
During the day and night collections

Organism	AUG. 1		AUG. 4		AUG. 6		AUG. 8	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Protozoa								
Dinoflagellates	1	2	1	2	1	2	1	2
Noctiluca	2	3	3	3	2	2	3	3
Tintinnids	2	3	2	3	2	3	2	3
Formaniferams								
Coelenterata								
Medusae	1	2	2	3	2	3	2	3
Ctenophora								
Turbellaria		1		1		1		
Chaetognatha		1	1	1		1		
Nematoda				1	1	1	1	1
Annelida								
Young and Adults		1	1	1		1		
Trochophores								
Arthropoda								
Misc. Crustaceae*	3	3	3	3	3	3	3	3
Nauplei		2		2			1	1
Cyprids		2		2	1	1	1	1
Zoea		2		2		1	1	1
Megalops	2	2	2	2	2	2	1	1
Mollusca								
Veligers	1	2	1	2	1	2	1	1
Echinodermata								
Bipinnaria		1		1		1		1
Pluteus	1	1	2	2	1	2	2	2
Appendicularia	1	2	1	2	2	2	2	3
Pisces								
Immature								

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE II, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
During the day and night collections

Organism	AUG. 11		AUG. 13		AUG. 15		AUG. 18	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Protozoa								
Dinoflagellates	1	2	1	1		1		1
Noctiluca	2	3		2		2		2
Tintinnids		3	2	3	2	3	2	3
Formaniferams								
Coelenterata								
Medusae	2	3	1	2	1	3	1	1
Ctenophora								
Turbellaria				1		1		1
Chaetognatha						1		1
Nematoda	1			1	1	1	1	
Annelida								
Young and Adults		1	1	1	1	1		1
Trochophores								
Arthropoda								
Misc. Crustaceae*	3	3	3	3	3	3	3	3
Nauplei	1	1	1	1		1		1
Cyprids	1	1	1	1		1		1
Zoea	1	1	1	1				
Megalops	1	1	2	3	2	3	2	3
Mollusca								
Veligers	1	1		2		2		2
Echinodermata								
Bipinnaria		1		1		1	1	2
Pluteus	1	1						
Appendicularia	2	2	2	3	2	3	2	3
Pisces								
Immature								

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE II, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
During the day and night collections

Organism	AUG. 20		AUG. 22		AUG. 25		AUG. 27	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Protozoa								
Dinoflagellates		1		1		1		1
Noctiluca		2		2	1	1		1
Tintinnids	2	3	2	3	1	3	1	3
Formaniferams								
Coelenterata								
Medusae		1		1		1		
Ctenophora						1		1
Turbellaria		1						
Chaetognatha		1						
Nematoda					1	1	1	1
Annelida								
Young and Adults		1		1		1		1
Trochophores								
Arthropoda								
Misc. Crustaceae*	3	2	2	2	2	2	2	2
Nauplei		1		1		2		2
Cyprids		1		1		2	1	2
Zoea		1		1		2		2
Megalops	2	3	2	3	1	2	1	2
Mollusca								
Veligers		2				2		2
Echinodermata								
Bipinnaria	1	2	1	2				
Pluteus								
Appendicularia	2	2	2	2	1	2	1	1
Pisces								
Immature								

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE II, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
During the day and night collections

Organism	AUG. 29		SEPT. 1		SEPT. 3	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Protozoa						
Dinoflagellates		1		1	1	1
Noctiluca		1		3	1	3
Tintinnids	1	3	1	3	1	3
Formaniferams						
Coelenterata						
Medusae						
Ctenophora		1				
Turbellaria						
Chaetognatha						
Nematoda	1	2	1	1	2	2
Annelida						
Young and Adults		3		2		1
Trochophores						
Arthropoda						
Misc. Crustaceae*	2	2	1	2	1	2
Nauplei		2		2		
Cyprids	1	2	1	2		
Zoea		2		2		
Megalops	1	1	1			
Mollusca						
Veligers		2		2		2
Echinodermata						
Bipinnaria						
Pluteus						
Appendicularia	1	1	1	2	3	1
Pisces						
Immature						

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE III

Phytoplankton occuring in plankton samples collected at Tomales Bay during the summer of 1952

	JUNE							JULY	
	16	18	20	23	25	27	30	2	4
Type									
Pleurosigma	1	1	1	3	2	2	2	2	2
Isthmus	1	1	2	3	3	2	2	2	2
Coscinodiscus	3	3	2	3	3	2	2	3	3

	JULY								
	7	9	11	14	16	18	21	23	25
Type									
Pleurosigma	2	2	2	2	3	2	2	2	2
Isthmus	2	2	2	2	1	1	2	2	3
Coscinodiscus	3	3	3	3	3	3	3	3	2

	JULY					AUGUST			
	28	30	1	4	6	8	11	13	15
Type									
Pleurosigma	2	2	3	3	3	3	2	3	2
Isthmus	2	3	3	3	3	3	3	3	3
Coscinodiscus	2	2	3	3	3	3	2	3	3

	AUGUST						SEPTEMBER		
	18	20	22	25	27	29	1	3	5
Type									
Pleurosigma	2	2	2	2	2	2	2	2	2
Isthmus	3	3	3	3	3	2	2	2	2
Coscinodiscus	3	3	3	3	3	2	2	2	2

Key:
1 - one or few
2 - common
3 - abundant or dominant

TABLE IV

Plants occuring in plankton samples from Tomales Bay during the summer of 1952 during the day and night collections

	JUNE 16		18		20		23		25		27		30		JULY 2	
Sample Type	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Pleurosigma	1	1	1	2	1	2	3	3	2	2	2	2	2	3	2	3
Isthmus	1	1	1	2	2	3	3	3	3	3	2	2	2	3	3	3
Coscinodiscus	3	3	2	3	2	3	3	3	3	3	2	2	2	3	3	3

	JULY 4		7		9		11		14		16		18		21	
Sample Type	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Pleurosigma	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Isthmus	3	3	2	2	2	2	2	2	2	2	1	2	1	1	2	2
Coscinodiscus	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

	JULY 23		25		28		30		AUGUST 1		4		6		8	
Sample Type	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Pleurosigma	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
Isthmus	2	2	3	3	2	3	3	3	3	3	3	3	3	3	3	3
Coscinodiscus	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3

	AUGUST 11		13		15		18		20		22		25		27	
Sample Type	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Pleurosigma	2	2	3	3	2	2	2	2	2	2	2	2	2	2	2	2
Isthmus	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Coscinodiscus	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

	SEPTEMBER 29		1		3		5		8		10		12		14	
Sample Type	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Pleurosigma	2	2	2	2	2	2	2	2	2	2	1	2	1	2	1	2
Isthmus	2	2	2	2	2	2	2	2	2	2	1	2	1	2	2	2
Coscinodiscus	2	2	2	2	2	2	2	2	2	2	1	2	3	3	2	3

Key:
D - day
N - night
1 - one or few
2 - common
3 - abundant or dominant

TABLE V

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
high and low tide

Organism	JUNE 16		JUNE 18		JUNE 20		JUNE 23		JUNE 25	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Protozoa										
Dinoflagellates	1	1	1	1	1	1	1	2	1	2
Noctiluca	1	2	1	2	1	2	1	2	1	2
Tintinnids		2		2		2		2		
Formaniferams		1		1		1		1		1
Coelenterata										
Medusae		1		1				1		3
Ctenophora		1		1						3
Turbellaria		1		1	1	1				3
Chaetognatha		1	1	1	1	1				3
Nematoda		1		1	1	1				3
Annelida										
Young and Adults		1		1		1		2		2
Trochophores		1		1		1				
Arthropoda										
Misc. Crustaceae*	2	2	2	3	3	2	3	3	3	3
Nauplei	2	1	2	1	2	1	2	1	2	1
Cyprids	2	1	2	1	2	1	2	1	2	1
Zoea	2	1	2	1	2	1	2	1	2	1
Megalops	3	2	3	2	3	2	3	2	2	2
Mollusca										
Veligers	3	2	3	2	3	2	3	2	3	2
Echinodermata										
Bipinnaria	3	3	3	3	3	3	2	2	2	2
Pluteus	2	3	2	3	2	3	2	3	2	3
Appendicularia	3	2	3	2	3	2	3	2	3	2
Pisces										
Immature										

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE V, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
high and low tide

Organism	JUNE 27		JUNE 30		JULY 2		JULY 4		JULY 7	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Protozoa										
Dinoflagellates	1	2	1	2	1	2	1	2	1	2
Noctiluca	1	2	1	2	1	2	1	3	2	3
Tintinnids				2	2	2	2	2	2	2
Formaniferams		1		2		2		2		2
Coelenterata										
Medusae		3	1	3	1	3	1	3	1	3
Ctenophora		2		2		2		2		2
Turbellaria		2	2	2	2	2	2	2	2	2
Chaetognatha		2		2		2				
Nematoda		2		2						
Annelida										
Young and Adults		2	2	3	2	3	2	3		3
Trochophores		2	3		3	2	2	1	3	1
Arthropoda										
Misc. Crustaceae*	3	3	3	2	3	2	3	3	2	3
Nauplei	2	1	3		3	2	2	2	2	2
Cyprids	2	1	2	2	2	2	2	2	2	2
Zoea	2	1	2	1	1	2	2	2	2	2
Megalops	3	2	3	1	3	2	3	1	3	2
Mollusca										
Veligers	3	2	3	1	3	1	3	1	3	1
Echinodermata										
Bipinnaria	2	2	3	3	3	2	2	2	2	2
Pluteus	2	3		3		3		3		3
Appendicularia	2	3	3	2	3	2	3	2	3	2
Pisces										
Immature				3		3		3	3	3

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE V, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
high and low tide

Organism	JULY 9		JULY 11		JULY 13		JULY 16		JULY 18	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Protozoa										
Dinoflagellates	1	2	1	2		3	1	3	1	3
Noctiluca	2	3	2	3		3	2	3	2	3
Tintinnids	2	2	2	2		1		1		1
Formaniferams		2		2		2		2		2
Coelenterata										
Medusae	1	3	1	3	1	3	1	3	1	3
Ctenophora		2		2	1	1	1	2	1	2
Turbellaria		2			1	1	1	2	1	2
Chaetognatha		2			1	1		2	1	2
Nematoda		2			2	2	2	2	2	2
Annelida										
Young and Adults		3		3	2	2	2	2	2	2
Trochophores	2	1	3	1	3	2	3	2	3	2
Arthropoda										
Misc. Crustaceae*	2	3	2	2	3	2	2	2	3	1
Nauplei	2	2	3	2	3	2	2	2	3	1
Cyprids	2	2	3	2	3	2	2	2	3	1
Zoea	2	2	3	2	3	2	2	2	3	1
Megalops	3	2	3	2	3	2	3	2	3	1
Mollusca										
Veligers	3	1	3	1	3	2	3	2	3	2
Echinodermata										
Bipinnaria	2	2	2	2	2	2	2	2	3	2
Pluteus		3		3	2	2	2	2	2	2
Appendicularia	3		3		2	2	2	2	2	2
Pisces										
Immature		3	2	3	2	3	2	3	2	3

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE V, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
high and low tide

Organism	JULY 21		JULY 23		JULY 25		JULY 28		JULY 30	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Protozoa										
Dinoflagellates	1	3	1	3	1	3				
Noctiluca	2	3	2	3	2	3	2	3	2	3
Tintinnids		1		1		1				
Formaniferams		2		2		2		2		2
Coelenterata										
Meduase	2	3	2	3	2	3	1	3	1	3
Ctenophora	1	2	1	2			1	3		
Turbellaria	1	2	1	2			1	2		1
Chaetognatha	1	2	1	2			1	2		1
Nematoda	3	1	3	1	3		1	2		1
Annelida										
Young and Adults	2	2	2	2	2	2	1	2	1	1
Trochophores	3	2	3	2	3	2	3	2	3	2
Arthropoda										
Misc. Crustacean*	2	1	2	1	2	1	3	2	3	2
Nauplei	2	1	2		2		2	1	2	1
Cyprids	2	1	2	1	2	1	2	1	2	1
Zoea	2	1	2	1	2		2	1	2	1
Megalops	3	1	2	1	2	1	3	3	3	2
Mollusca										
Veligers	3	2	3	2	3	2	3	2	3	2
Echinodermata										
Bipinnaria	3	2	3	2	3	2	3	2	3	2
Pluteus	2	2	1	1	1	1	1	1	1	1
Appendicularia	2	2	2	2	2	3	2	3	2	3
Pisces										
Immature	2	3	2	3	1	3	2	2	2	1

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE V, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
high and low tide

Organism	AUG. 1		AUG. 4		AUG. 6		AUG. 8		AUG. 11	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Protozoa										
Dinoflagellates										
Noctiluca	2	3	2	3	2	3	2	3	3	3
Tintinnids										
Formaniferams		2		2		2		2		2
Coelenterata										
Medusae	1	2	1	1	1	2	1	2		2
Ctenophora										2
Turbellaria		1		1		1		1	1	2
Chaetognatha		1		1		1		1	1	2
Nematoda		1		1		1		1		2
Annelida										
Young and Adults		1		1		1		1	2	2
Trochophores	3	2	3			3		3	2	2
Arthropoda										
Misc. Crustaceae*	3	2	3	2	3	2	3	2	2	1
Nauplei	2	1	2	1	2	1	2	1	2	1
Cyprids	2	1	2	1	2	1	2	1	2	1
Zoea	2	1	2	1	2	1	2	1	2	1
Megalops	3	2	3	2	3	2	3	2	2	1
Mollusca										
Veligers	2	2	2	2	2	2	2	2	2	1
Echinodermata										
Bipinnaria	3	2	2	3	2	2	2	2	2	1
Pluteus	2	2	2	3	2	3	2	3		
Appendicularia	2	3	2	3	2	3	2	3	2	3
Pisces										
Immature	1	1	1						1	1

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE V, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
high and low tide

Organism	AUG. 13		AUG. 15		AUG. 18		AUG. 20		AUG. 22	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Protozoa										
Dinoflagellates									2	3
Noctiluca	3	3	3	3	2	3	2	3	2	3
Tintinnids									1	
Formaniferams		2		2	2			2		2
Coelenterata										
Medusae	1	2	1	2	1	2		2	2	3
Ctenophora		2		2	1	2		1	1	1
Turbellaria	1	2		2		2		1	1	1
Chaetognatha		2	1	2	1	2		1	1	1
Nematoda	1	2		2		2		1	1	1
Annelida										
Young and Adults	1	1	1	1	1	1	1	1	3	2
Trochophores	1	1	1	1	1	1	1	1	3	2
Arthropoda										
Misc. Crustaceae*	2	1	2		3	1	2	1	2	2
Nauplei	2	1	2		2	1	2	1	2	
Cyprids	2	1	2		2	1	2	1	2	
Zoea	2		2		2	1	2	1	2	
Megalops	2	1	2	1	2	1	2	1	2	
Mollusca										
Veligers	2	1	2	1	2	1	2	1	2	
Echinodermata										
Bipinnaria	2	1	2	1	2	1	2	1	2	
Pluteus									2	2
Appendicularia	2	3	2	3	2	3	2	3	2	3
Pisces										
Immature	1	1	1	1	1	1	1		1	

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE V, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
high and low tide

Organism	AUG. 25		AUG. 27		AUG. 29		SEPT. 1		SEPT. 3	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Protozoa										
Dinoflagellates	2	2	2	3	2	3	1	2	1	2
Noctiluca	2	2	2	2	2	2		3		3
Tintinnids	1			1	1			1		1
Formaniferams		2		1		1				1
Coelenterata										
Medusae	1	3		3	1	3		1		2
Ctenophora	1	2	1	2	1	2		1		2
Turbellaria	1	2	1	2	1	2		1		2
Chaetognatha	1	2	1	2	1	2		1		1
Nematoda	1	2	1	2	1	2		1		1
Annelida										
Young and Adults	3	2	3	2	3	2	2	1	2	2
Trochophores	3	2	3	1	3	1	2		2	1
Arthropoda										
Misc. Crustaceae*	3	2	3	2	3	2	3		3	
Nauplei	2	1	2	1	2	1	2		1	
Cyprids	2	1	2	1	2	1	2		1	
Zoea	2	1	2	1	2	1	2		1	
Megalops	2	1	2	1	2	1	2		1	
Mollusca										
Veligers	2		2		2		2		2	1
Echinodermata										
Bipinnaria	2		2		2		2		2	
Pluteus	1	2	1	2		2		2		2
Appendicularia	2	3	2	3	2	2	2	2	2	2
Pisces										
Immature										

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE V, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
high and low tide

Organism	SEPT. 5		SEPT. 7		SEPT. 9		SEPT. 11		SEPT. 13	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Protozoa										
Dinoflagellates	1	2	1	2	1	2	1	2	1	2
Noctiluca		3		3		1		1		3
Tintinnids		1								
Formaniferams		1				1		1		1
Coelenterata										
Medusae		2		2	1	2	1	2	1	2
Ctenophora		2			1	2	1	1	2	2
Turbellaria		2			1	2		2	2	2
Chaetognatha		2			1	2	1	1	2	2
Nematoda		2			1	2		1	2	2
Annelida										
Young and Adults	2	2	2	2	2		2		2	
Trochophores	3	1	3	1	2		2		2	
Arthropoda										
Misc. Crustaceae*	3		3	2	3	2	3	2	3	2
Nauplei	1		1		2		3		3	
Cyprids	1		1		2		3		3	
Zoea	1		1		2		3		3	
Megalops	1		1		2		3		3	
Mollusca										
Veligers	2		2	1	2		2		2	
Echinodermata										
Bipinnaria	2		2			2		2		2
Pluteus		2	1	2						
Appendicularia	2	2	2	2	2	2	2	2	2	2
Pisces										
Immature							3		3	

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE V, Cont'd.

Animals occuring in plankton samples from
Tomales Bay during the summer of 1952
high and low tide

Organism	SEPT. 15	
	LOW	HIGH
Protozoa		
Dinoflagellates	1	2
Noctiluca		3
Tintinnids		
Formaniferams		1
Coelenterata		
Medusae	1	2
Ctenophora	2	2
Turbellaria	2	2
Chaetognatha	2	2
Nematoda	2	2
Annelida		
Young and Adults	2	
Trochophores	2	
Arthropoda		
Misc. Crustaceae*	3	2
Nauplei	2	
Cyprids	2	
Zoea	2	
Megalops	3	
Mollusca		
Veligers	2	
Echinodermata		
Bipinnaria		
Pluteus		
Appendicularia		
Pisces		
Immature		

Key:
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

TABLE VI

Seasonal variations in plankton samples
from Tomales Bay

Organism	MARCH 22	JUNE 23	SEPTEMBER 19	DECEMBER 13
Protozoa				
Dinoflagellates	2	3	2	2
Noctiluca	2	3	2	1
Tintinnids	2	1	1	1
Formaniferams	1		1	1
Coelenterata				
Medusae	3	2	1	A
Ctenophora	2	3	1	3
Turbellaria	2	2		1
Chaetognatha				
Nematoda	1	1	A	A
Annelida				
Young and Adults	3	3	1	1
Trochophores	2	2	1	A
Arthropoda				
Misc. Crustaceae*	3	3	3	2
Nauplei	2	2	2	1
Cyprids	2	2	1	A
Zoea	2	2	1	A
Megalops		3	2	A
Mollusca				
Veligers	3	1	A	A
Echinodermata				
Bipinnaria	3	1	A	A
Pluteus	2			
Appendicularia	3	2	2	A
Pisces				
Immature				

Key:
A - absent
1 - one or few
2 - common
3 - abundant or dominant
*Includes:

Amphipods	Isopods
Copepods	Mysids
Euphausids	Ostracods

EXPLANATION OF PLATES

PLATES 1 AND 2

Common types of phytoplankton taken from Tomales Bay.

PLATES 3, 4, 5 AND 6

Common types of zooplankton taken from Tomales Bay.

PLATE 7

Map of Tomales Bay, California. Dark star indicates chief collecting area for plankton studies.

PLATE 8

Photograph of Nick's Cove showing the pier from which most of the collections were made.

PLATE 9

Map of Tomales Bay showing the rate flow of an incoming tide. (Experiment, page 5.) Small stars indicate route taken by Flow Register; large stars indicate ten minute time intervals.

PLATE 10

Photograph of laboratory materials used in this investigation: Clip board with check sheets (Plate 11), pint water

bottle, 24-guage, 12-inch opening plankton net with 6-ounce collection bottle at the lower end, pencils, quart bottles, thermometer calibrated in 0.1 of a degree, large culture bowls, finger bowls, Syracuse watch glasses, graduated cylinder, wax pencil, hollow ground glass slide, ten percent neutralized formalin, dissecting microscope, light, salinity hydrometer, Knudsen's salinity tables, and a compound microscope which was omitted from the photograph.

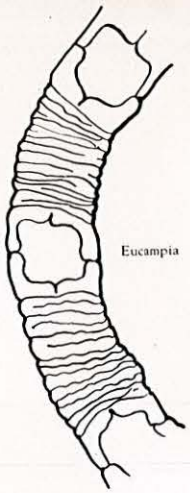
PLATE 11

Copy of one of the mineographed sheets used for recording all examinations of sea water and plankton samples.

PLATE 1

COMMON TYPES OF PHYTOPLANKTON

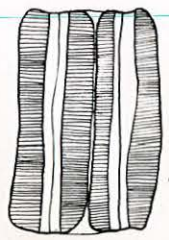
Leptocylindrus



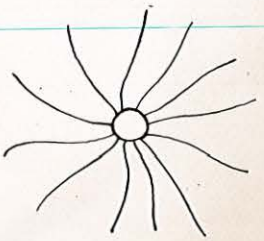
Eucampia

Stephanopyxis

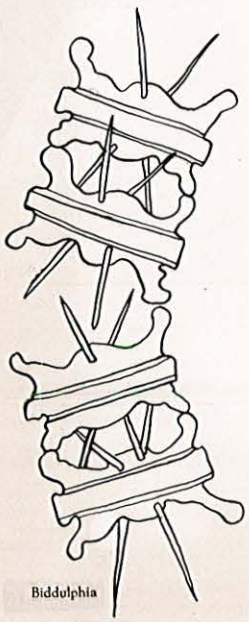
Rhizosolenia



Grammatophora

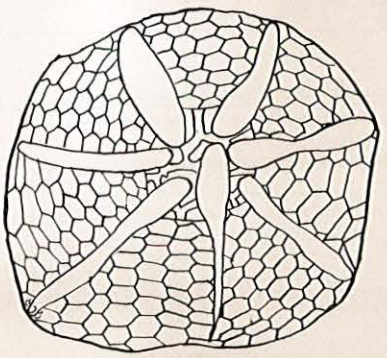


Bacteriastrum



Biddulphia

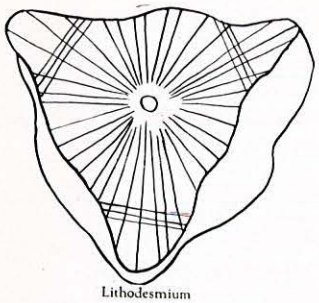
Thalassiosira



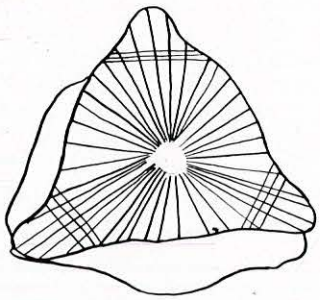
Asteromphalus

PLATE 2

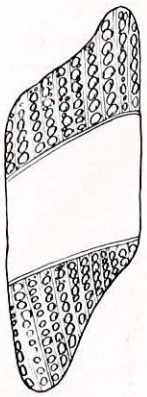
COMMON TYPES OF PHYTOPLANKTON



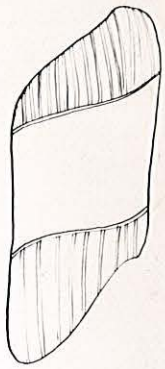
Lithodesmium



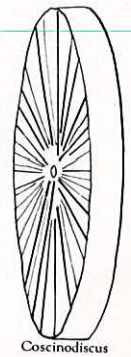
Lithodesmium



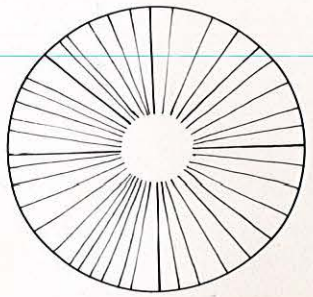
Isthmia



Isthmia

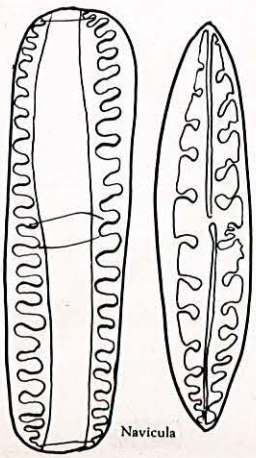


Coscinodiscus

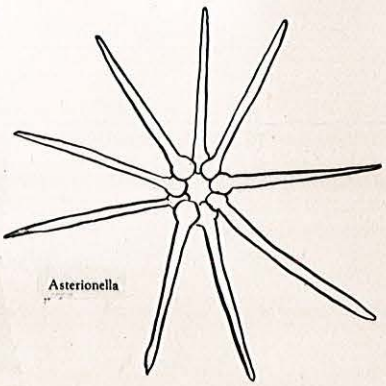


Coscinodiscus

Pleurosigma



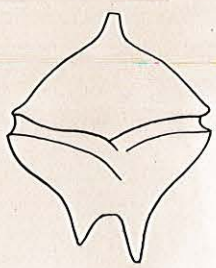
Navicula



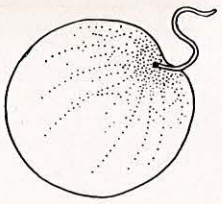
Asterionella

PLATE 3

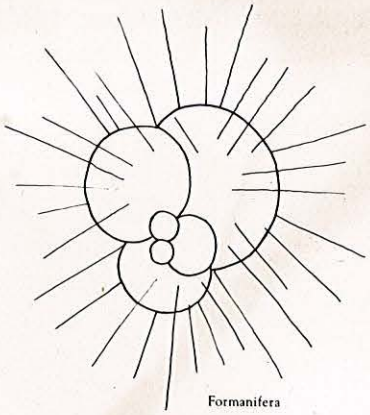
COMMON TYPES OF ZOOPLANKTON



Peridinium
Dinoflagellate

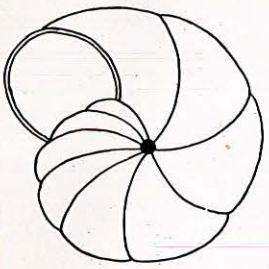


Noctiluca

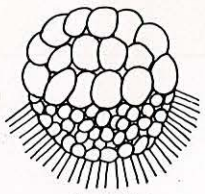


Formanifera

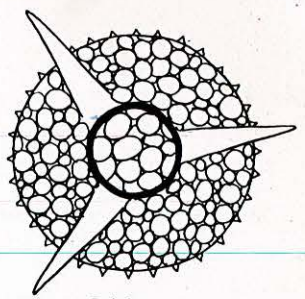
Tintinnid



Formanifera

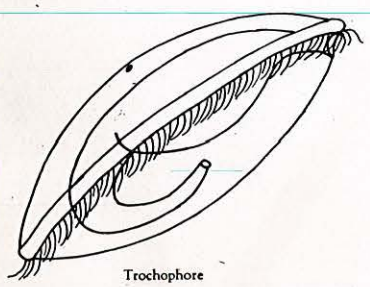


Amphiblastula
Larval Sponge

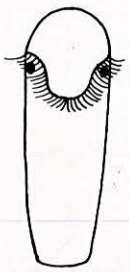


Radiolaria

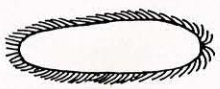
Trochophore



Trochophore

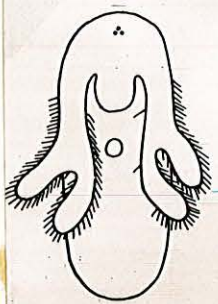


Trochophore, Phoronid

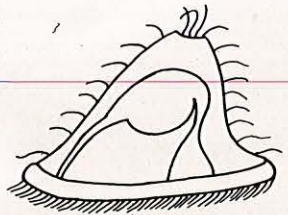


Planula
Larval Coelenterate

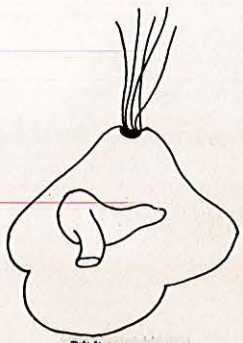
Actinotrocha
Phoronid Larva



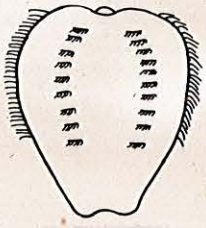
Muller's Larva
Turbellarian Larva



Cyphonautes
Bryozoan Larva



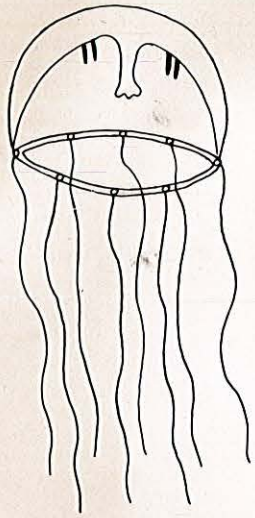
Pilidium
Nemertean Larva



Ctenophore Larva

PLATE 4

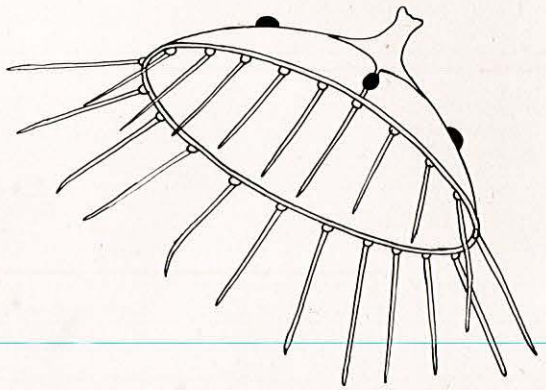
COMMON TYPES OF ZOOPLANKTON



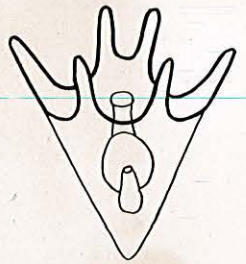
Hydrozoan Medusa

Bipinnaria
Starfish Larva

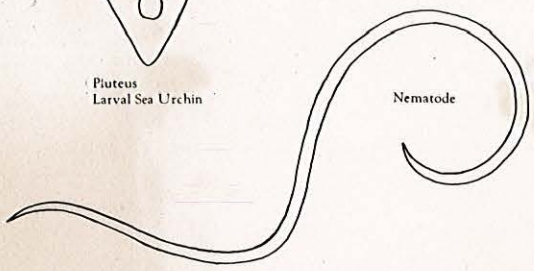
Rotifer



Hydrozoan Medusa

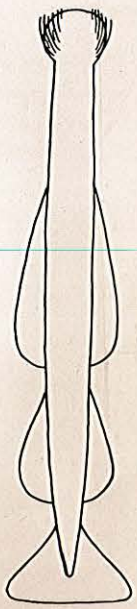


Pluteus
Larval Sea Urchin

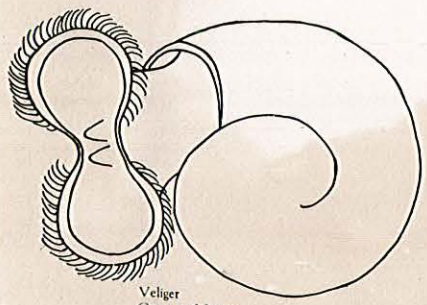


Nematode

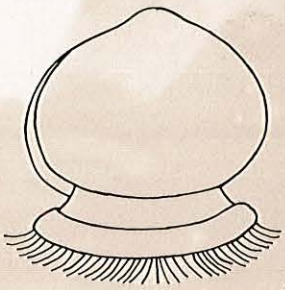
Young Turbellarian



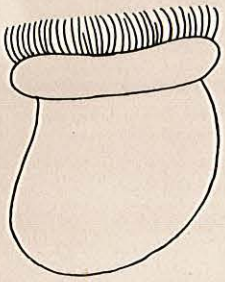
Sagitta



Veliger
Gastropod Larva



Veliger
Pelecypod larva



Veliger

PLATE 5

COMMON TYPES OF ZOOPLANKTON

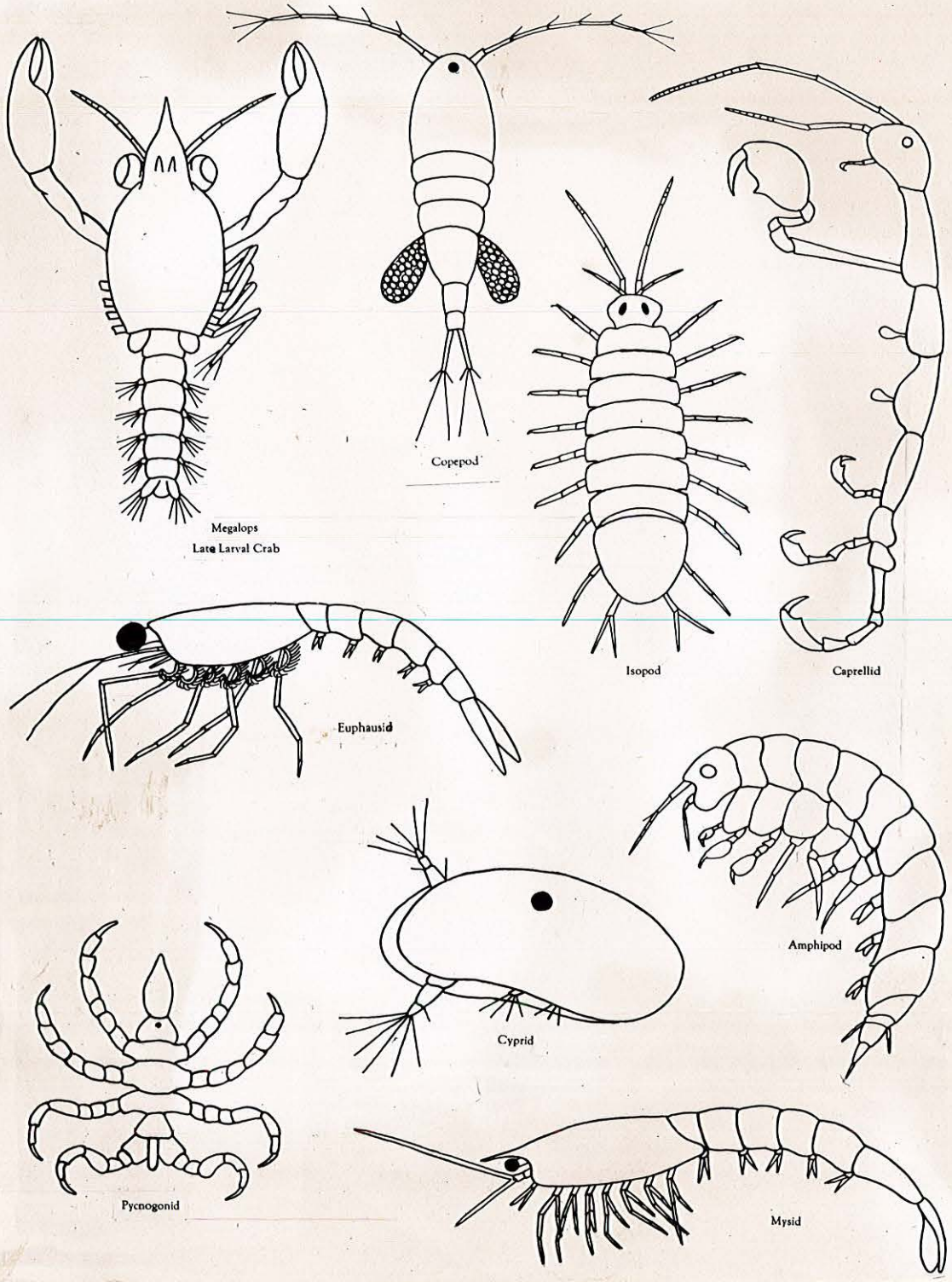
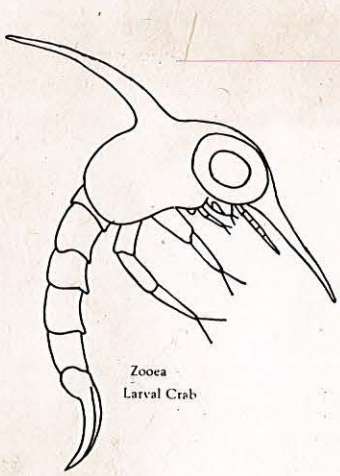
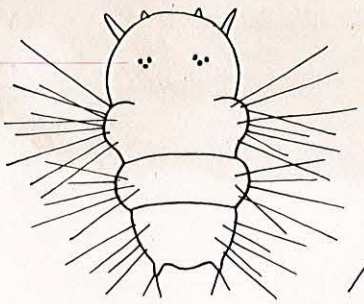


PLATE 6

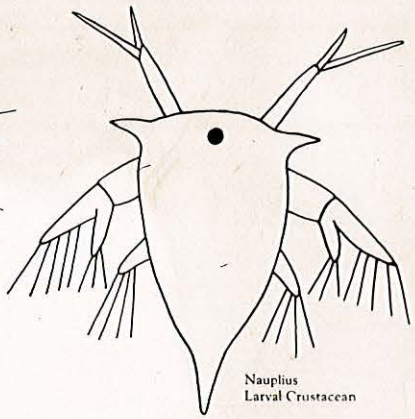
COMMON TYPES OF ZOOPLANKTON



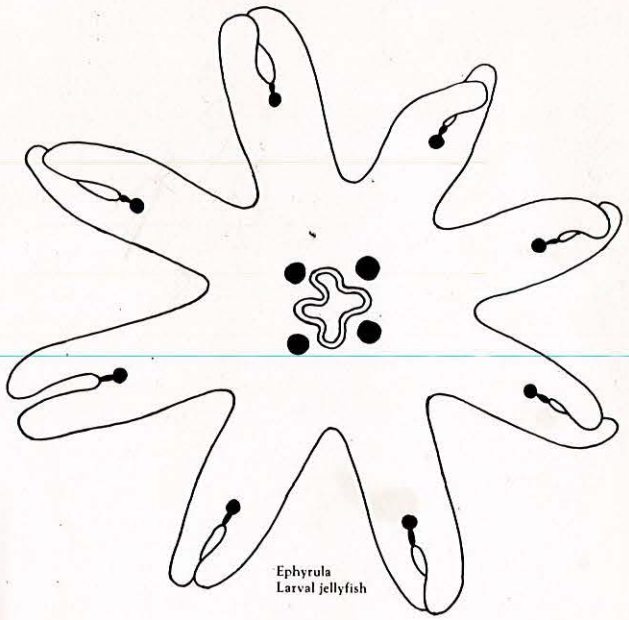
Zooea
Larval Crab



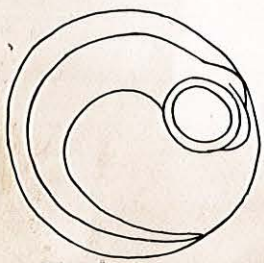
Young Annelid



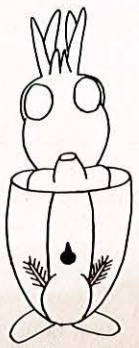
Nauplius
Larval Crustacean



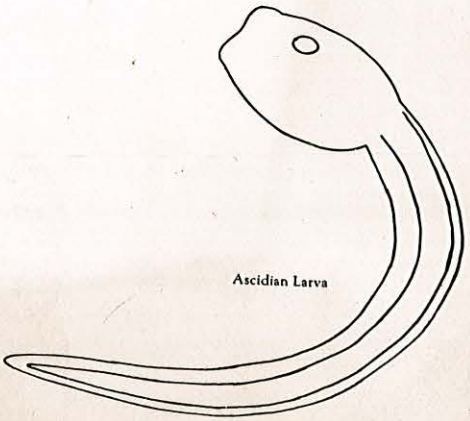
Ephyrula
Larval jellyfish



Fish Embryo in Egg



Young Squid



Ascidian Larva

PLATE 7

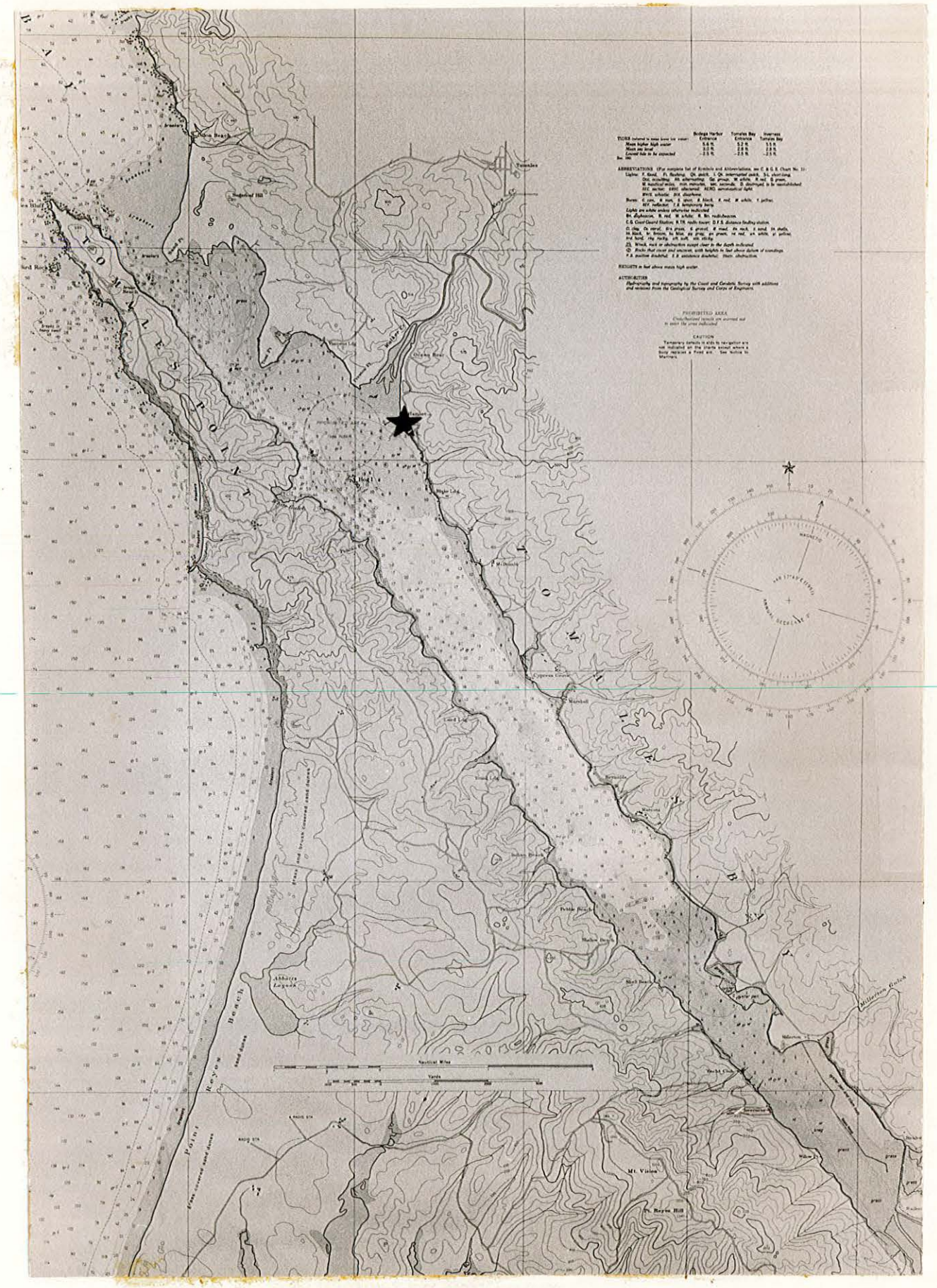

Tomales
Hamlet
Tomales Bay
Bodega Harbor Entrance
Tomales Bay Entrance
Inverness Tomales Bay
Millerton Gulch
Mt. Vision
Mt. Reyes Hill
Nautical Miles
Yards

PLATE 8

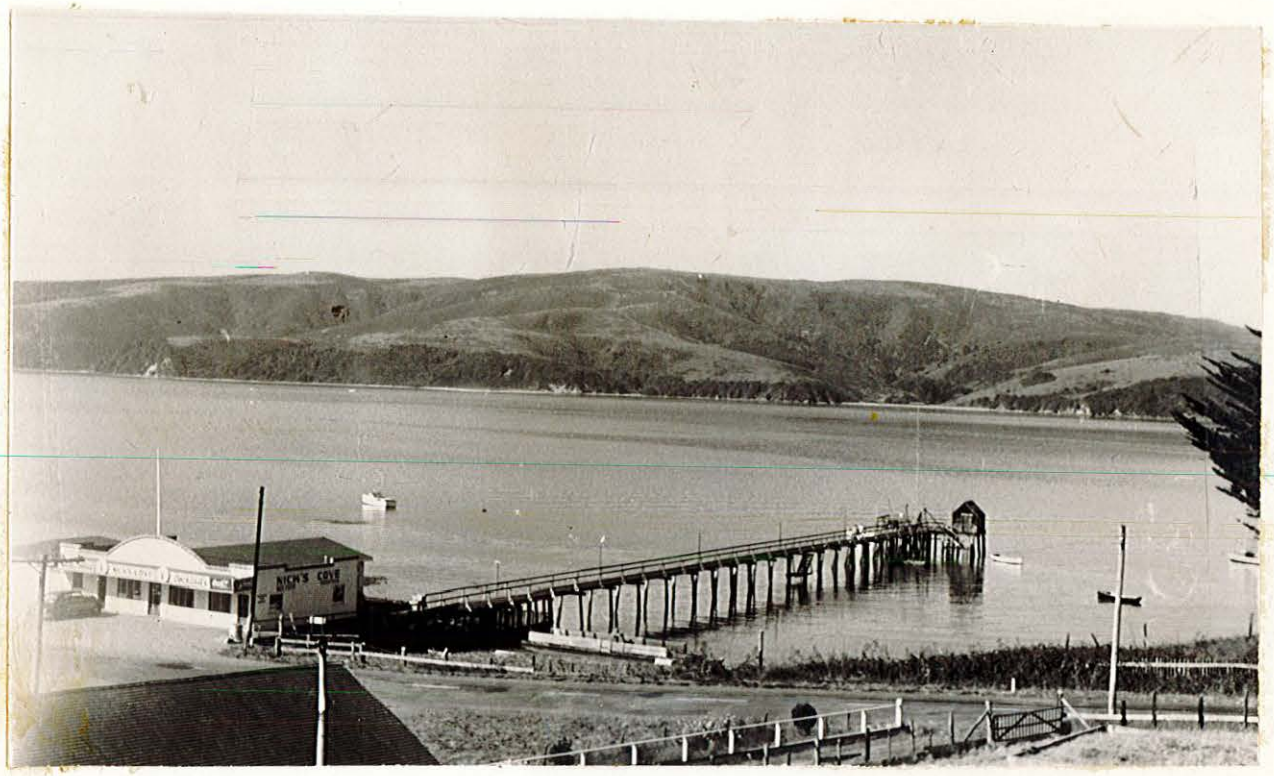


PLATE 9

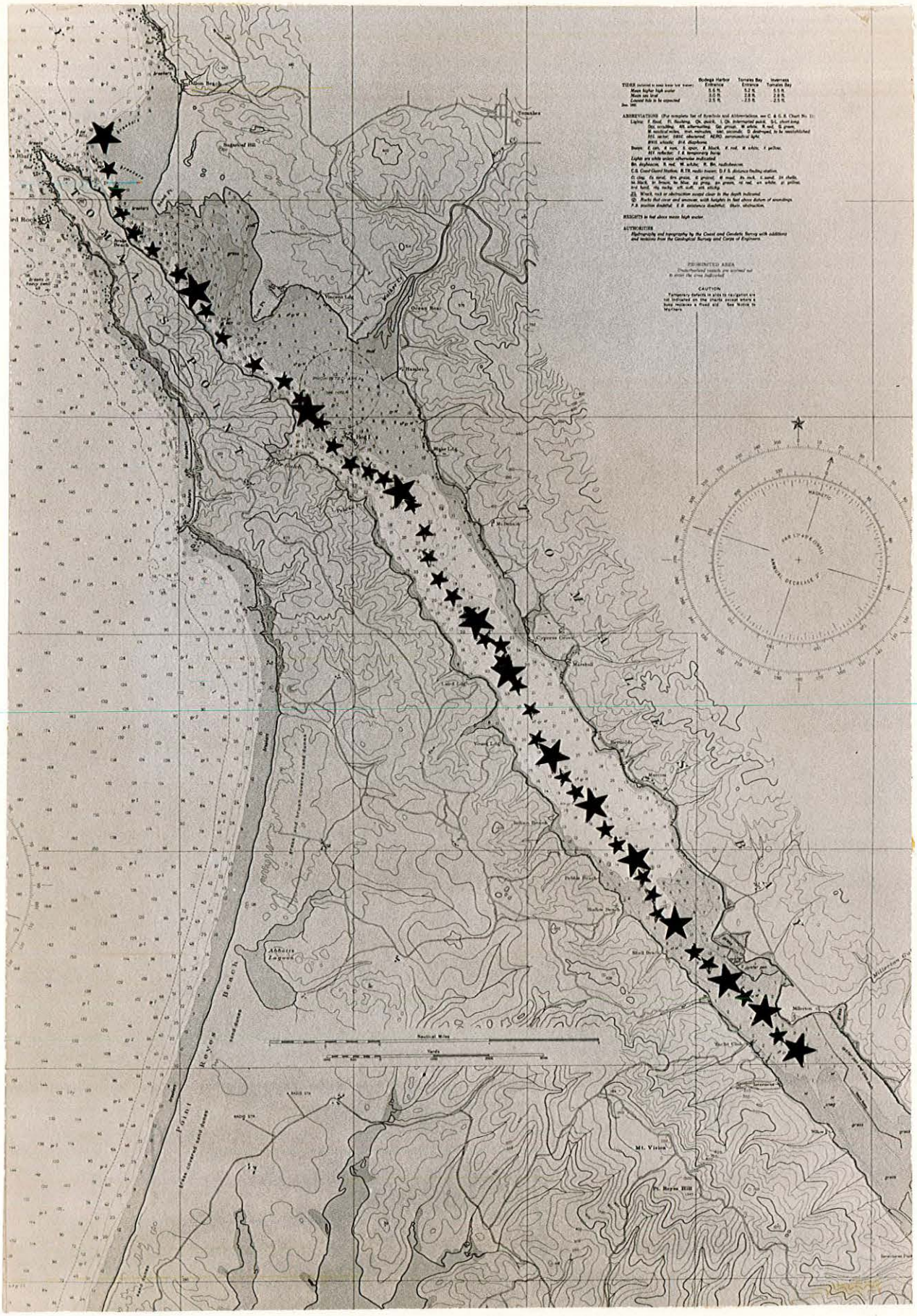

Point Reyes Beach
Mt. Vision
Abbotts Lagoon
Tomales
Inverness
Marshall
Millerton
Nautical Miles
Yards

PLATE 10

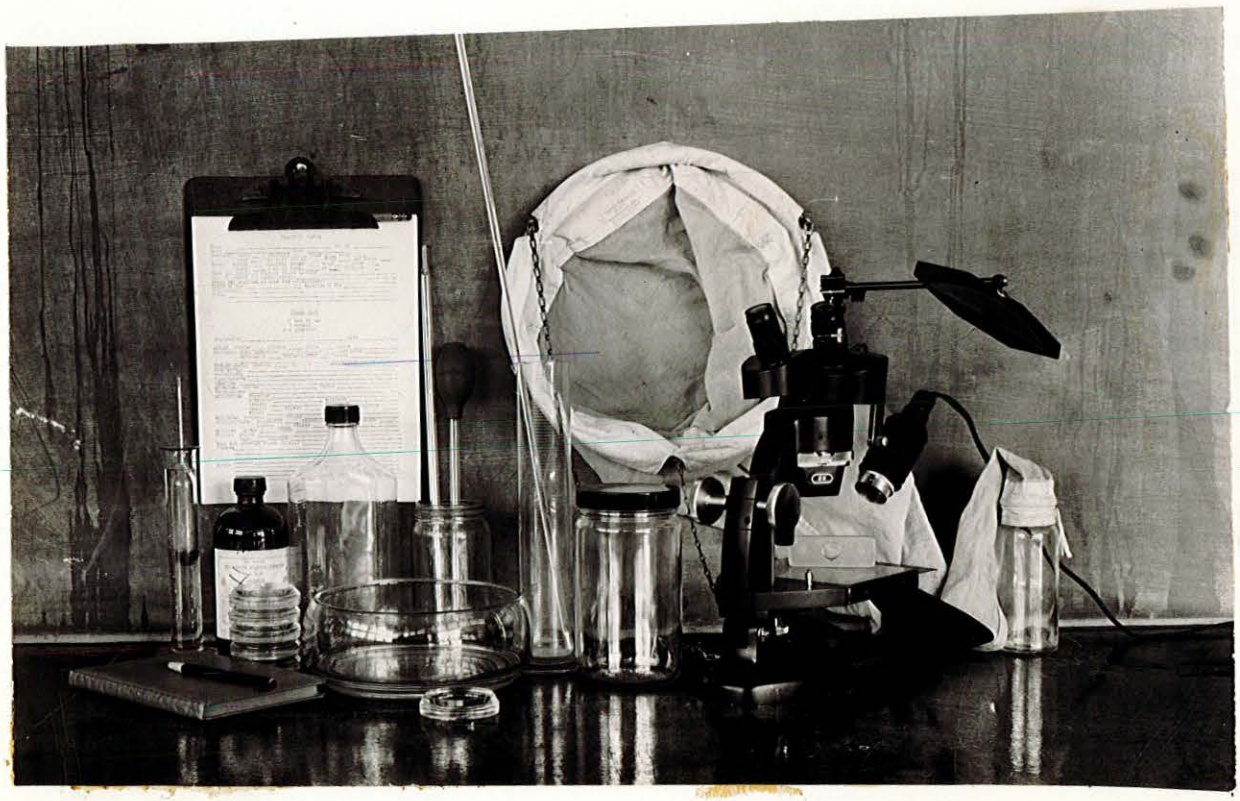


PLATE 11

PLANKTON RECORD

Place NICKS COVE, TOMALES BAY CALIFORNIA Tow No. 2
Date July 17, 1952 Time 2030 to 2045 - 15 MIN.
Weather: clear ____ overcast X ____ foggy ____ rainy ____
calm ____ moderate breeze X ____ windy ____ air temp. 17°C
Water: smooth ____ slightly rough X ____ rough ____ clear ____
"muddy" X ____ surface temp. 16.5C ph ____ salinity 24
Time and height of nearest tidal extreme 2048 +3.6
Time of sunset (if significant) 1815 DAYLIGHT SAVING TIME
Phase and position of moon (if significant) LAST QUARTER
Depth of tow Surface to 2½ feet Duration of tow 15 MINUTES
Collector(s) Andrew McClain, DR G.E Nobbe
Notes: Subsurface temperature of water 16°C

Check List

1 - one or few
2 - common
3 - abundant or dominant

Examiner(s) Andrew W. McClain Date July 18, 1952-6:30A.M.

ALGAE: needle 1 pillbox 3 chain 2 others Round Chains
PROTOZOA: Dinoflagellates 3 Noctiluca 2 Tintinnids 1
Radiolaria 1 Formaniferams 2 Others ____

COELENTERATA: Medusae 3 Planulae 2 Others ____
CTENOPHORA: 2
TURBELLARIA: 3
CHAETOGNATHA: 2
NEMATODA: 2
ANNELIDA: Adults 3 Young 2
TROCHOPHORES: 2
ARTHROPODA: Copepods 3
Ostracods 2 Amphipods 1
Isopods 3 Euphausids 2
Nauplei 3 Cyprids 2 Zoea 3 Megalops 3
Others NONE
MOLLUSCA: Veligers 2 Others ____
ECHINODERMATA: Bipinnaria 1 Brachiolaria 2 Auricularia 1
Pluteus 2 Others ____
ASCIDEA: Larvae 2 Others ____
FISHES: Adults 1
Eggs 3 Immature 2
EGGS AND CLEAVAGE STAGES (MISC.): ____
OTHERS: Numerous Actinotrocha
BRYZON FRAGMENTS - SOME CYPHONAUTES
NOTES: Numerous Rotifers
Numerous Muller's Larva, Pilidium.